BOSTON PUBLIC LIBRARY
3 9999 08654 553 8

BOSTON PUBLIC LIBRARY.
CANCELLED
CANCELLED
CHILDREN'S ROOM.
NOT TO BE TAKEN AWAY
Form No. 328.

No. 7598.45

GIVEN BY

The Publishers.

HOW SHALL MY CHILD BE TAUGHT?

Practical Pedagogy; or, The Science of Teaching Illustrated

By LOUISA PARSONS HOPKINS

SUPERVISOR IN BOSTON PUBLIC SCHOOLS

12mo CLOTH $1.00 net

The papers contained in this volume were originally published in the "Primary Teacher," and attracted a great deal of attention for the practical views advanced. "The Boston Herald" says, —

"Mrs. Louisa P. Hopkins has made a careful, practical study of the science of teaching, and her book will be of the greatest service to those who are engaged in the tasks of primary teaching. She is less didactic than experimental in her methods; but the points which she makes are those that lead inevitably to success, because they have been proved in the schoolroom, and have the authority of the great schoolmasters of modern times. The secret of Mrs. Hopkins's success lies in the following of the natural laws of education. These are laws of mental action, when the mind is free to act under the impulse of play instead of taskwork. The method cannot be reduced to rule; it is the method of the live teacher, who feels with the child, and guides and inspires his mental action.

THE SPIRIT OF THE NEW EDUCATION Cloth $1.50

The addresses in this work have an underlying unity of thought, represent advanced theories, and afford high ideals for the development of character and the training of the young. The earnestness and sincerity of the author are undeniable, and she presents her ideas vigorously, and with a strong flavor of discussion. Manual training, the kindergarten, physical training, elementary science, the public school curriculum, moral education, women's work in education, are among the many subjects treated, with a clearness and emphasis that make a lasting impression. — *Boston Times.*

OTHER WORKS BY SAME AUTHOR

OBSERVATION LESSONS IN THE PRIMARY SCHOOLS. In Four Parts. Paper. Price, each part, net 15

In One Volume, Cloth, net 75

EDUCATIONAL PSYCHOLOGY: A Treatise for Parents and Educators. Cloth $0.50

HAND-BOOK OF THE EARTH: Natural Methods in Geography. Cloth 50

NATURAL HISTORY PLAYS, DIALOGUES, and RECITATIONS for School Exhibitions. Boards net 30

BREATH OF THE FIELD AND SHORE. Cloth . . 1.25

MOTHERHOOD. Cloth. Full Gilt 1.50

EASTER CAROLS. Palatine Boards .50

LEE & SHEPARD Publishers Boston

OBSERVATION LESSONS

IN THE

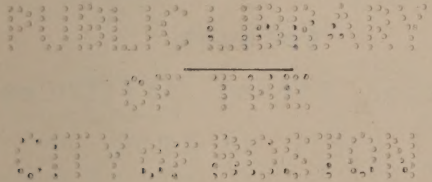
PRIMARY SCHOOLS

A Manual for Teachers

BY

LOUISA P. HOPKINS

SUPERVISOR OF ELEMENTARY SCIENCE IN BOSTON PUBLIC SCHOOLS



BOSTON 1896

LEE AND SHEPARD PUBLISHERS

10 MILK STREET NEXT "OLD SOUTH MEETING HOUSE"

School-Book Collection

Copyright, 1889,
By Lee and Shepard

Gift of Publishers
through
Boston School Committee
April 1902

CONTENTS

PART FIRST.

SENSE LESSONS.

	PAGE
Education through Self-Activity	1
General Directions for Lessons	5
Programme for the Work in Boston Public Schools	9
Suggestions for Lessons on Color	14
Lessons on Color	20
Suggestions for Lessons on Form	26
Lesson on Form	32
Suggestions for Lessons on Place	34
Suggestions for Lessons on Size	39
Suggestions for Lessons on the Qualities of Objects	41

PART SECOND.

PLANT AND ANIMAL LIFE.

Elementary Science	43
Plant Life	47
An Attempt to utilize Outdoor Material in the Schoolroom	57
Observation of Animal Life	61
Questions to be Applied to Subjects of Observation	62
Model Lessons on Animal Life	66
Oral Lessons on Birds	80

PART THIRD.

PHYSICAL PHENOMENA OF NATURE — THE HUMAN BODY.

PAGE

PHYSICAL PHENOMENA OF NATURE 91
OBSERVATION LESSON IN PHYSICS 94
PRIMARY CLASS IN PHYSICS 105
THE HUMAN BODY 130
PRIMARY CLASS IN PHYSIOLOGY 133

PART FOURTH.

PHYSICAL EXERCISE AND MANUAL TRAINING.

PHYSICAL EXERCISE 181
OBSERVATION AND DEMONSTRATION LESSONS IN MANUAL TRAINING 193
MORAL TRAINING INVOLVED IN MANUAL TRAINING . 196
HAND AND TOOL WORK 199
PAPER FOLDING AND CUTTING 199
GEOMETRIC EXERCISE IN PAPER-FOLDING . . . 200
SEWING 202
CLAY-MODELLING 203
DRAWING 204
KNIFE WORK IN WOOD 206
THE PURPOSE, RULES, AND PLAN OF THE SLÖJD . 207
GENERAL OUTLINE FOR DEMONSTRATION LESSONS . 210

PART FIRST

SENSE LESSONS

EDUCATION THROUGH SELF-ACTIVITY

IN

OBSERVATION, THOUGHT, AND EXPRESSION

THE Observation Lessons provided by the Course of Study for Primary Schools are for the training of the senses in order to gain fundamental facts of knowledge through self-activity, to establish the child's relations with the world of matter and to awaken his mind and soul. Through complete observation we lay the foundation of knowledge, which, by the assimilative power of the mind, is converted into active energy of thought, demanding expression in outward forms.

Observation should therefore be connected invariably with expression.

Expression is the natural complement of observation and thought.

No thought is complete which is not expressed.

Every child has an impulse for expression, which should be fostered by the teacher. Expression consists in the embodiment of thought or feeling through some material form or external activity.

Expression may be by the movement of the face, the eyes, or the body; by words both oral and written; by industrial or artistic work in any material; by music, and by dramatic action.

Every child should be introduced to all forms of expression until his natural aptitude is discovered. Manual training gives facility and skill in dealing with every variety of material for expression and is therefore a necessary preparation for all effort toward expression.

The observation and expression lessons of a class should be so conducted as to involve the body, the mind, and the soul, of every child. Nature exercises these several functions in every act of the child's development.

The physical activity of observation is in the use of the senses and muscles in acquiring information; the mental activity of observation is in the perception and intelligence awakened; the soul activity is in the love, reverence, or joy, which may be excited by observation of natural forms and phenomena and communion with nature.

The physical activity of expression is in the manipulation or bodily action exercised in production; the mental activity is in the completion of the ideas resulting from observation, and in the exercise of the creative power of the mind; the soul activity is in the accompanying emotion of love, sympathy, or reverence, or in the conception of the ideal involved in expression.

Any work of observation or expression for the child which omits any one of these functions is partial and imperfect, and so far a failure in educative power or completeness.

The unity of the threefold nature of the child should be preserved in every process of education.

The observation lessons provide an opportunity to learn what the senses may tell, so that the mind may gain ideas; the expression lessons provide an opportunity to put these ideas into some form, which shall communicate them to others; they should aim to make the child industrious, originative, and benevolent; they should contain as much of his individuality as possible, and busy him in productive work, either to express his ideals or his love for others, or to be helpful to others, — thus establishing his human and divine relationships.

In this way, the child makes his connection with nature, with man, and with God, and develops symmetrically every part of his being.

Training in observation, or training of the senses, increases the power to learn and the power to think; training in expression, or manual training, increases the power to think also, completing and defining the thought by giving it outward form, and impressing that outward form with its own originative impulse. Expression should always be associated with a moral impulse, that the exercise of the moral nature may produce moral strength. Thus the physical, mental, and moral nature of the child are all involved in the observation and expression lessons.

The observation lessons are in furtherance of the natural activity of the senses, which are the child's earliest and best means of knowledge, and connect him with the external world.

The expression lessons are in furtherance of the natural activity of the muscles in completing thought,

and connecting the child with the world of matter and the world of mankind as a productive moral agent.

The observation work is an extension of the sensory nervous system, and conveys knowledge and ideas to the brain; the expression work is an extension of the motor nervous system, and connects the creative thought with matter again; the one receives what the material universe has to give; the other gives back to the outside world what it receives, plus the individual thought and motive which impresses it.

We must aim to give the child complete and accurate knowledge through the senses, and to lead him to complete and accurate expression through his powers and means of expression.

Both observation and expression should be as spontaneous as possible, but carefully trained under the direction of one who understands the laws of the child's development, and who offers to the child an inspiring sympathy as well as a responsive interest and knowledge concerning the subject of study and work. Observation, thought, expression: these include all the means of development which can be offered to the human being.

GENERAL DIRECTIONS FOR LESSONS

1. THE observation and elementary science lessons have for their first object the cultivation of the powers of observation.

2. The object to be studied should be in the hands of every child in the class, either for the whole or a part of the time of lesson.

3. The object should be observed by the child, not only with one sense, as, for example, *sight*, but by every sense which may be applied to it with safety.

4. The child should have an opportunity to see it under pleasurable excitement of attention, and should be directed by the teacher's questions toward interesting and important points of observation.

5. The object should be observed, not alone as a single thing, but as related to other things.

6. The quality to which observation is directed should be distinguished in a variety of things. The faculty of comparison should be developed from observation, by distinguishing the same quality in two or more objects, and noticing their likeness and difference.

7. The faculty of classification should follow comparison, by teaching the child to arrange in groups objects having common qualities.

8. The faculty of relating cause to effect and effect to cause should follow, involving the logic of structure and function in living forms, and of origin, history, and uses, in inorganic material.

9. All the departments of elementary science should be constantly related to each other, in presentation, in observation and expression, as far as possible.

10. The lessons should not be made tiresome by dwelling too long upon one isolated point of observation, or by too much repetition. One fact gained, or one quality observed, will be constantly revived in successive objects of observation, and in its natural associations, so that it is unnecessary to attempt a tedious drill in each lesson.

11. As far as possible, the class should help the teacher and each other in the conduct of the lesson, and be busy in a spontaneous way about it, under the sympathetic control of the teacher.

12. It is always well to seize upon some incidental occurrence or object of interest connected with the children's work or play for the subject of a lesson, and, whenever practicable (which is usually the case), allow the object to be contributed, or at least suggested, by the children or by one child.

13. If the object of observation is a plant or animal, take great pains to have a living specimen, rather than a dead one ; and something familiar to the children, rather than unfamiliar.

14. Make a few strong points in each lesson, and lead the children to see the relation between them, and wherein they are characteristic of the individual or the class which they represent.

15. In studying a simple object, teach the child to regard it in its activity and motion, as well as at rest ; showing what it does as well as what it is.

16. In studying the activities of natural forms, lead the child to discern the laws of those activities, and the results of resistance to those laws.

17. Point out to the child's thought whatever symbolism lies hidden in any form or process of matter, as soon as he seems capable of perceiving it, and encourage him to reach out from the material to the spiritual. Trace the continuity of law in all processes, — physical, mental, and spiritual.

18. Do not attempt observations which are too nice and complete for the child's comprehension at any stage of the work.

19. Do not, at any time, present points of observation which are accidental or individual, so much as those which are inherent and general.

20. Begin the training of expression in various ways as soon as clear observation is finished.

21. Lead the child into various forms of expression, as they prove attractive and practicable, until he takes pleasure in a variety of expression.

22. Language or expression may be in the form of oral or written words, drawing, moulding, and the beginnings of industrial occupation with every available material; written expression should be more and more required as the child matures.

23. Combine industrial or manual training, as far as practicable, with all elementary science work.

24. Attention from inherent interest, and not from outward compulsion, should accompany every lesson.

PROGRAMME FOR THE WORK IN BOSTON PUBLIC SCHOOLS

THE observation work, as arranged for the primary schools, is under four separate heads :

1. Sense lessons in (a) color, (b) form, (c) place, (d) size, (e) qualities.
2. Plant and animal life.
3. The human body.
4. Physical phenomena of nature.

SENSE LESSONS.

The time given to this department is two hours a week, or fifteen minutes in each session, four days of the week, during one fourth of the year.

An observation lesson may be given in the morning, and an expression lesson in the afternoon, each fifteen minutes in length. The language and drawing, and what is called "busy work" in the primary schools, as well as sewing, cooking, experiments in physics, and other work requiring manual training in the upper schools, may be regarded as expression lessons, or lessons in manual training.

The lessons in observation and sense-perception are for the purpose of training the senses, to make them accurate and thorough in observing the phe-

nomena presented to the senses: they train the eye to nice and complete cognition of light and shade, color, form, size, distance, texture, surface, and all qualities which may be perceived by the eye, so as to furnish the mind with facts of knowledge and ideas which shall arouse the thought; — they train the ear to accurate and discriminating observation of sound, of pitch, of tone, of harmony, of rhythm, etc.; — they train the touch to complete and accurate observation of surface, size, form, direction, texture, and all qualities which may be distinguished by that sense, and they train the senses of smell and taste, also, to a cognition of those facts which respond to their exercise; — they train the senses as a whole to act in conjunction, to correct each other, and to supply each other's deficiencies, giving at last the most complete knowledge of material things, and adjusting the child to his surroundings. These senses, like all other powers of the child, are improved and developed by exercise, and both observation and expression are essential elements of that exercise.

The senses of the child are his first instruments of knowledge. His eyes inform him of light, color, form, size, and motion; his ears give him sound, which conveys to his mind a range of facts of another kind, and forms a medium of communication with others; smell and taste give ideas of odor and flavor, which attract or repel, and furnish knowledge which is useful for his well-being; feeling informs the mind of various qualities of objects, and with all the senses connects him with the external and material world wherein he is

to live and which he is to make subservient to his uses. Ideas and knowledge can reach him in no other way than through the exercise of these senses.

COLOR.

There are several excellent manuals accessible on this subject, which may be all that the teachers need for direction. Miss Crocker's manual of color is used by many, with various material collected by the teachers for illustration. Colored worsteds, papers, etc., also small bottles of colored liquids, which are easily used for mixing colors, and producing various colors or tints, are provided for many classes: colored crayons and paints are also used by many for the expression lessons in color. All these are easily provided, and furnish the material necessary for the color lessons. Miss Crosby's elaboration of method is given as a sample of what may be done on such a basis of material.

Dr. Jeffries' color chart and disks have been much used, with satisfactory results. Prang's manuals and directions to accompany these have proved very serviceable. In place of the chart and disks in some classes, pieces of silk, cotton, or worsted have been substituted as specimens of color. Mrs. Caroline F. Cutler, of the Lucretia Crocker School, has prepared charts of pure specimen shades, in various fabrics, very well graded, and ready for the teacher's use, with directions for using. These serve admirably with Miss Crocker's manual. They may be obtained at the School Supply Company, 15 Bromfield Street, or at Ed. Pub. Co., 50 Bromfield Street, at one dollar for

the mounted specimens, or one-half dollar for the unmounted, with the directions.

Miss Emma R. Marwedel, a well-known kindergartner, has published a very fine course in color and form combined, which may be obtained of S. C. Heath, Somerset Street, Boston. It presents many original suggestions for the development of the work, and novel and admirable material to accompany the manual and charts. This system is endorsed by distinguished educators in this country and Europe.

The subject may be studied in any good kindergarten manual, so as to apply to primary school work, as well as to kindergarten.

Appended are a variety of suggestions for color lessons in the primary schools. If any are found to be impracticable, it is hoped that they may at least suggest some which are practicable. I think it of great importance that room should be left for original thought and development of the subject by the individual teachers, as nothing is so valuable as individuality in teaching, and such inspiration as is aroused by individual study of methods. I am very anxious not to cramp the teachers by a minute and exacting course of directions in the elementary science work, but to encourage the original application of principles by every teacher. Above all, I would desire that the work should be free, and filled with life and feeling. The present conditions and methods are too dead and mechanical. It would be of the greatest value to put life and living forms and processes before the children in all these departments, in order to inspire a vital and lively interest, original

investigation, and creative production, always relating all parts of the work to each other, and to the grand inclusive thought of nature in the works of nature, which illustrate every idea that the teacher is striving to communicate to the child.

SUGGESTIONS FOR LESSONS TO DEVELOP IDEAS OF COLOR

Take the prismatic colors as the standard of color, making each color the pure spectrum pattern.

1. Blow a soap bubble until color begins to streak it; call attention to the color as it spreads, — blue, red, yellow. Let those who look on name the colors.

What is the color? Show that it is caused by light.

Who painted it? The sun. See the reflection of surrounding objects on its surface, and the color of things reflected; are these colors the same as the colors which streak the bubble? What are the colors? blue, red, yellow; — these are the colors of light. But what is the general color of light? it is white; the color of sunshine? yellow; the color of the sky and water? blue; the color of the evening sky? the color of the setting sun? red.

2. Bring a prism into the schoolroom. Hang it in the sunlight; swing it in and out of the direct sunlight. What color is the light through it when it swings, out of the sunlight? white; in the sunlight? rainbow colors. What are they? red, blue, yellow. Are they like the color on the bubble? Why called rainbow colors? What is the rainbow? have the children seen it? Show one when occasion offers, and direct the children's observation to the succession of colors; it is

the sunlight broken up into its colors, — blue, red, yellow; the raindrops are the prisms.

Show a raindrop, if possible, suspended on a blind, or a stem or line, and look into it for the prismatic colors.

What is a prism? a glass prism? a crystal? Show them to the children. Let children handle the prism, and blow the bubble, and say the names of the colors.

3. Busy work. Distribute colored papers, or worsted scraps, shells, pebbles, or minerals, and colors in any objects to be assorted. Let children bring red flowers, blue flowers, yellow flowers.

Let children find and name these colors in dress, picture, furniture, etc.. Let them name red flowers: rose, poppy, clover, maple-flower; blue flowers: pansy, forget-me-not, bachelors' button, larkspur, blue flag, harebell; yellow flowers: dandelion, buttercup, marigold, goldenrod.

4. Prism lesson to teach shades of color: orange is red and yellow mingled; green is blue and yellow mingled; violet is blue and red mingled. Teach shades, tints and hues — watch the prismatic shades on the desk, the floor, the wall, the blackboard; on a white screen or curtain. Point out the prismatic colors in their order, — red, orange, yellow, green, blue, violet; observe how red and yellow shade into each other and mingle in the orange; how yellow and blue shade into each other, and mingle in green; how blue and red shade into each other, and mingle in violet.

5. Give "busy work" of worsted or paper to assort by shades. Twist blue and yellow together, and make

the string vibrate rapidly, to show green; twist red and yellow together and vibrate, to show orange; twist blue and red together and vibrate, to show violet.

Put red and yellow tissue paper, one upon the other, against the window and let the light shine through them to show orange; the same with blue and yellow, to show green; the same with blue and red, to show violet. Show white, which is the color of light, or all colors combined harmoniously.

Let the children design in color, and decorate according to their fancy with paints or colored pieces arranged symmetrically, or with the needle. Many valuable suggestions for color and form exercises can be found in manuals, cards, and charts, published by Prang's Educational Company, also in Miss Marwedel's "Childhood's Poetry and Studies in the Life, Form, and Colors of Nature," published by D. C. Heath.

6. Put white tissue paper and red tissue paper on the window, and show pink; white and yellow, and show light yellow; white and blue, and show light blue; white and green, and show green; white and dark violet (purple) and show purple. Vary the degrees of shading by doubling the white or the color.

7. Speak of darkness, as the absence of light; — the color of darkness is called black; it is where no light, and therefore no color, is thrown out to the eye. Put black tissue paper with each color of tissue paper, and show the dark shades; put a little white with black, and make grey; a little red with black, or yellow with black, and make various shades of brown.

8. "Busy work" of assorting shades of one or two

colors, with worsteds, or tissue paper, or ribbons, or any patterns of color.

9. Select colors which harmonize or please the eye, and colors which contrast agreeably; arrange them in rows alternately.

10. Mix the colors of paints; paint little squares of kindergarten paper with each of the two colors and with their combination.

red	or	blue	or	red
violet		green		orange
blue		yellow		yellow

11. Resume the experiments with soap bubble; let each line of desks have an attendant with bowl and pipe, so that each child may try the bubble-blowing, and observe the colors carefully to distinguish them. Let the four children nearest the one who blows the bubble name and point out the colors.

12. Resume the prism experiment, and let the prism hang suspended in the sunlight through the lesson, or let it be passed from child to child, if practicable. Let each test the effect and point out the colors thrown on a white surface.

13. Let each child have unassorted specimens of every shade, and arrange them by colors and shades and hues.

14. Give colored crayons to make pictures of rainbows on the slate, or blackboard, or paper. Let the children color pictures of flowers or other subjects, the

colors of which they know. Let them draw forms of fruit or flower with colored crayons.

15. Let the children paint every color and shade, each in a line of kindergarten squares, until able to put on the color evenly and clearly.

Speak of and show, if possible, signal lights and their color significance, for cars, for ships, for stations; colors of flags for vessels, and for representing countries and nations. Talk of the meaning of colors, — colors as symbols: white, of innocence; violet, of truth; red, of feeling; blue, of purity, etc. What are the colors of nature? what colors are found together in nature? in one flower, or in flowers growing near each other? *e.g.* purple aster and goldenrod, blue harebell and brown grass or grey stone, black and yellow sunflower and white and yellow daisy, white lily with yellow stamens, red roses and green leaves and grass, blue and white violets, etc., etc.

Show the colors of various metals and minerals; of various creatures; of fishes, sea animals, plants and shells. Beauty and harmony are shown by color; we see but the three colors and their shades; light may easily include colors we have not the power to see; our eye sees but these, some creatures' eyes may see other colors.

Show how color of various animals corresponds to their surroundings: the butterfly's color is like the flowers it visits; the striped tiger, like the light and shade of the jungle; the tawny lion, like the desert sands; the tropical insects and birds, like the brilliant flowers of the same regions; the silver fox, and the white bear and snowy owl, like the arctic snows, etc.

Speak of colors all cannot see; the blind eye, the eye which grows blind from lack of use; the mole, etc.; blind children; people who are color blind; colors corresponding to sounds; colors which are seen in the light of stars; the color of a burning object shows the kind of substance of which it is made; the colors in the sun's light show of what it is made, the solar spectrum; What does color tell us? Proportion and relative arrangement of color makes its beauty more perfect and apparent. The use of color to the artist; the colors in old frescos, etc., in draperies and rugs, in landscape painting and portrait painting.

Show the children large masses of color, the massed green of an orchard or fields. Present to their observation the whole surface of the Common or Public Garden, or any park. Call their attention to the toning down of the colors of nature, by the mixing of shades, the brown twigs or boughs in the green foliage, the shadows on the grass, the grey sky or dark water, the autumn hues massed in harmonious gradations of reds, yellows, and browns, — all under the varying lights and shadows. Show the children the crudeness of artificial coloring as compared with nature's coloring. Let them look from their abrupt contrasts of paint and pieces of colored paper, to the evening sky, to the garden of foliage and bloom, to the landscape, wherever they may see it, and notice the difference in the effects of nature and art.

Show the children how color is always associated with joy; how dull and uninteresting nature would be without it.

Show them the gradual shading of color in the corolla of a flower, in the surface of fruit, and in the mass of foliage of a tree or bush. Let them learn by frequent and thoughtful observation how beauty is expressed by color, not by abrupt and crude shades, but by harmonious gradations of tints in all natural objects. Let them discover that nature never defines and contrasts color sharply and suddenly, but mingles and softens and tones in all shades, so as to give *rest* to the eye.

Let the children sometimes close their eyes, and imagine color; let them describe their mental image of color or copy it. Let them sometimes lay on color in masses, without form, and experiment with shades and harmonies of color in the mass, and learn to discriminate between what is hard and crude, and what is soft, rich, and harmonious.

Let them try to imagine a world without color, and realize how beneficent an element it is in the material creation. Show how color attracts insects to flowers, in order that they shall assist in its cunning contrivances for fruitage. Orchids may be shown to illustrate this use of color.

LESSONS ON COLOR

ARRANGED BY MISS CROSBY OF THE MARTIN SCHOOL.

HAVING provided as many objects as possible of different colors, — cards, blocks, beads, pieces of worsted, silk, ribbon, etc., — ask the children if they look alike. At first, hold up objects of the same color, then those of different colors, and see if the children can distinguish those that are alike from those that are

unlike. Thus, holding up two red cards, ask the children if they are of the same color, then two green objects, two yellow objects. After this is done, take a red and a green object, hold them up before the class, and see if they can notice the difference between them. Then take up a green and yellow object in the same way.

After the children are able to distinguish one color from another, then teach the names of the colors. Take up a red object, as a block, and have the children select one like it, giving the name of the color, red. Point to a green object in the schoolroom, and let the children find one like it, giving the name of the color, green. The names of the other colors may be taught in a similar manner, varying the exercises to keep up the interest of the children.

When the children have had considerable drill in naming colors, let them think of a certain color. Take green. Tell them to think of a green object, a tree, a plant, etc. Let them find a green object in the schoolroom, and so on with the other common colors.

Write on the blackboard the names of some of the principal colors, red, green, violet, yellow, etc., and ask the children to name objects that are red, then write the names under the word *red*, and then let them name green, violet, and yellow objects in the same way. Let them make out a list of red objects, yellow objects, etc.

Procure large cards and cut out pieces of bright-colored paper in the shape of the different triangles, squares, oblongs, and paste them on the cards. Holding up a colored square, have the children select one of the same *shape*. Pass out some of the cards to the children, and, holding up another of a different shape, as a triangle, tell those pupils to stand who have the same *shape*, and at the same time tell the color of their triangle. After calling for the different *forms*, then hold up before the class a certain color and ask all who have the same *color* to stand up.

For practice on color and form, the following is a good plan: On cards, draw a square, with its diameters, and cut out pieces of paper to correspond in shape and size, and pass them out to the children to match. On other cards draw squares, with their diag-

onals and cut out pieces of paper to match in form and size, and let the children match them. This might serve as busy work.

Have the children provided with a number of bright-colored beads. Tell them to put on two red beads and one black bead, three yellow beads and two blue beads, — and so on. Splints may also be used in this way. Place on the desks, in rows, three red splints, two green ones, etc.

After arranging different objects on the table, have a child select a red card; another, a red block; a third, a piece of red ribbon. Ask one to point out any red object in the room; another, any red color in the dress of any of the children. Ask them to name anything *red* they remember to have seen, as flowers, — rose, peony, geraniums; fruit, — apples, cherries, currants, strawberries, etc.

Have the children select all the yellow objects on the table, or in the schoolroom. Then ask them to think of something yellow which they remember to have seen. Flowers, — buttercups, daisies, sunflowers; fruits, — apples, bananas, lemons, pears; vegetables, — squash, turnips, etc. Let the children write these objects on their slates, and thus give some help in spelling and writing.

The other common colors may be taught in a similar way. Where the children bring covers for their desks, bright colors might be encouraged, and they could be used with some advantage in these lessons.

After considerable practice on the common colors, the shades, tints, and hues of those colors may be taught the children. Shades being more easily recognized by the children, they may be taken first. Having placed the color chart before the children, ask them to notice whether all of a certain color look *exactly* alike. Pointing to the brightest or standard red, ask them if all the reds are just the same. They will soon tell you that some are darker and others lighter than the standard. The other colors may be pointed out, with their shades, in the same way. Then they may be told that all the darker colors are called *shades*. When they are able to point out all the shades of a certain color, the small cards that accompany the chart may be passed out to the class, and, pointing to the brightest *green*, let the children find a card that matches it *perfectly;* then, pointing to a darker green on the

chart, let the children who have cards to match come to the chart and test theirs; then let them find one still darker. The shades of the other colors may, with slight variations, be taken in a similar manner.

After the children are able to select the brightest or standard colors, and their different shades, lead them to notice on the chart that there are some colors *lighter* than the standard ones. After they have found some of the lighter colors on the chart, the small cards may be passed out to the class, and, holding a bright-colored card, red, for instance, let those who have one to match it stand up. Then, taking a lighter red, show it to the class, and tell all who have one like it to hold it up. Pointing to a still lighter red on the chart, let all who have one to match come to the chart with theirs and see if they are correct. After the children have selected all the lighter colors, they may be told that all colors *lighter* than the brightest or standard colors are called *tints*.

In teaching shades and tints, sample cards of the Eureka Silk Mfg. Co., especially the sample cards of embroidery silk, also Clark's sample card of cotton thread may be used with advantage, as many of the shades and tints of all colors are arranged so correctly that they can be easily seen by the children. When all are able to name a shade or a tint at sight, a list can be made out and written on the board, to be copied by the class on their slates, as follows, —

Standard Colors	*Tints*	*Shades*
red	pink	cardinal
green	pea-green	olive
violet	lavender	purple

until the common shades and tints are known.

Until the children are able to recognize the common shades and tints, *hues* of the colors should not be taken up, as they would confuse them greatly. To show them some of the more common hues, place before the class a collection of the brightest colors, with their shades and tints, also some of the hues of those colors. Then, take a color, red, for instance, and place near it a shade and a tint of the same color. Then take a hue of red, say magenta, and place that with the red, and then lead the chil-

dren to notice that the magenta is not light enough to be called a tint, nor dark enough to be called a shade of red. In a similar way, the other colors may be shown the class. After the children are able to select some of these colors which cannot be called tints nor shades, as they are not decidedly lighter nor darker than the standards, they may be told that these colors are called *hues*. For review on shades, tints, and hues, a number of different colors may be placed on the table, and let one child select one color, green, for instance, together with its shade, tint, and hue; another take violet, with a shade, tint, and hue; and so on with the different colors. After practice in this way, the class may write out a list of colors as follows, —

Standards	*Shades*	*Tints*	*Hues*
red	cardinal	pink	magenta
green	olive	pea-green	grass-green
violet	purple	lavender	lilac

until they have found a number of the most common colors.

A glass prism hung in a window, so that the sunlight passes through it, will best show the children the true prismatic colors. For practice in these colors, use pieces of silk thread drawn through perforated cardboard, arranged in the same order as formed by the glass prism. The class might also form scales of different colors, with paper, or worsted, or silk, which would serve as review on tints and shades, —

flesh-color	light green
pink	pea-green
red	green
crimson	grass-green
cardinal	dark green, etc.

Lead the children to observe what colors *look well together*. The class is supposed to have had considerable practice in combining colors. So, having a number of colored objects, have one child select two colors which he thinks look well together. If right, let another find two more, until most of the colors have been taken by the class in this way. Then the children may be told that colors that look well together are said *to harmonize*. For practice on harmony of colors, a good plan would be to pass

out cards of different forms, as square, triangle, etc., of all colors, and let the children select the ones they think look best together; if a poor selection is made, let them try again, and they will probably do better. For further practice, they may form designs with these different cards.

In all these lessons, sample books of leatherette, also Rice Kendall & Co.'s paper, may be used with advantage, by cutting out the different colors, shades, and tints in the form of triangles, etc., and having the children use them in their designs.

M. E. CROSBY.

SUGGESTIONS FOR LESSONS ON FORM

1. Soap Bubble. It is round, a sphere; consider the outside, the inside, the centre; it is a hollow ball, a perfect shape; the air breathed into it pressing it outward, the air around it pressing it inward; every point on the outside is the same distance from the centre as every other point, every straight line going through the centre to the surface will be equal in length with every other.

The colors are on the surface, the thin wall of the bubble is of water, of varying thickness, the particles held together in that shape by the equal pressure without and within, until the limit of cohesion is reached.

It is a form of beauty, of symmetry or equal measurements; it is the form of nature; the earth is a sphere; we live on its surface; the stars and heavenly bodies are spheres.

Ball Lesson. The ball is a sphere, but not hollow; it touches a plane only on one point, it moves easily, swings, rolls, rebounds; if it is soft it yields to pressure on any part; squeeze the ball, make it look longer one way than another, flatter one way than another, as you press it more firmly on one side or another.

Swing the ball by a string; it moves in a curve backward and forward, it oscillates, it comes to a stop gradually. If you swing the ball round and round by the string, it moves in a curved or circular path, every-

where the same distance from the centre, that distance being the length of the string. The string is the radius, the distance across the circular path is the diameter, or measure through the circle, the distance around the path is the circumference, or measure around the circle; the plane of the ball's motion, or that which is within the circumference, is the circle.

3. Draw on the blackboard or slate, with chalk and a string, a circumference; it is the track of a point moving at an unvarying distance from another point.

Let the children practise this as an occupation, making the string of various lengths; or, let them practise freehand drawing of a circumference with two pieces of chalk and both hands at once, marking the centre by a dot; let them draw a diameter; let them erase the circumference on one side of the diameter, this is half a circle, or a semicircle. Let the children draw these forms until familiar with the meaning of the words: sphere, circle, centre, circumference, radius, diameter, semicircle, hemisphere. Let them design various figures which combine these.

3. Give each child an apple or orange, cut it across into halves, a hemisphere, one half of the plane surface of the hemisphere is a semicircle, the straight edge is a diameter.

How many diameters or circles can we make in a sphere?

Name things which are made in the form of spheres? round fruits, many eggs, little cells in the tissue of the leaf; show them by holding the leaf so that the light shines through it; each little cell is a hollow sphere

like the soap-bubble; it may be filled with juice, the juice bubbles, the cells swell, and grow, and divide, and press together, and make more cells, so that the leaf grows.

Let the class make forms bounded by planes, using paper, cut and folded, and draw the different planes separately as seen with the help of a stretched cord held horizontally or vertically before the eye. Practise looking at things as they touch such a line. A whalebone bent like a bow by a fine black silk thread stretched from one end to the other is the best instrument for the purpose. Manual training of all kinds leads to a study and knowledge of form and to form-expression in all material.

The sphere is the form of life, and the form of development.

4. When the little ant builds his house, he piles up the grains of sand in a circular heap. Why? He walks the same distance from the centre with his grains and leaves the outside grains equally distant from the centre.

Let the children make a dot on paper and make a number of straight lines leading out from it to represent the journeys of the ant, and then join the outside ends of the lines and form a circle. What is the shape of the daisy? It is round because the petals are rays of equal length coming from the centre, and that makes the outward edge seem round. The flower is symmetrical; every part measures the same. The morning glory has its outward edge all united; it is a cup.

5. If the ant travels around its heap, its path is cir-

cular; if a little bug crawls around an apple its path is circular; if a man travels all around the earth, his path is circular; a circular line ends where it began.

If a man starts and travels all around the world in one way, or path, he will come back to where he started. If men or horses run around a race course, they come back to where they started every time. Let the children try to form a circle by running. Teach the child to make the segments of the circle. Show him seed-vessels or fruits, and how in them nature has defined segments and forms which are bounded by a circle. Study the forms of leaves, and copy them.

Show various modifications of the circle, in the shape of flowers and fruits, of hydroids and other animals.

Make some easily prepared crystals chemically under the pupil's eye. Let the children make such as are practicable. They see the making or creating process of nature, of God's hand in the forces of nature.

Various prismatic forms can be shown by the balanced pressure of the sphere in an elastic material.

Show the blowing of many bubbles while holding the pipe in the basin of water, so that the pressure is equal on all sides of each bubble, and the greatest use is made of the space. This will produce hexagonal prisms of water in the place of spheres.

Then the cells of the bee for her wax, or the compound eyes of insects, should be shown as further illustrations of the economy of space, by the modification of the sphere where many are crowded together.

The cube and triangular prism should be made by symmetrical pressure on a clay sphere, and then crys-

tals in these forms should be exhibited as nature's effort after these forms or as types of these forms. All sorts of mineral prisms should be used as types of form hidden away in the rock, made by the balanced pressure of unseen hands called forces of nature.

The snow crystals may also be exhibited and used in illustration of the beauty and symmetry of form pervading nature, and in process of creation before our eyes.

Sand may be sprinkled on plates of glass and different points on the edge of the glass be struck by the tuning-fork, so as to produce regular geometrical figures of the sand on the glass, thus showing somewhat of the law of crystallization and the harmony of form produced by natural processes. This will be an illustration of unity as well as diversity of form. Beautiful forms in spicules of sponge and other animal tissues may be shown; the microscope may aid this observation.

Take Hills' Geometry for Beginners, and let the children learn to draw the geometrical forms by strict measurements. Follow out the geometric forms in drawing, and by folding, cutting, or moulding. Well elaborated lessons in mechanical form by Larkin Dunton, LL. D., have appeared in "The Public School." The work of form in all directions can be pursued as in the kindergarten, Miss Marwedel's treatise on form and color being an excellent guide. Practice in measurement should be associated with the study and practice of form. Foot-rules carefully marked in inches can be often in the hands of the children for experiment in

measuring. Apparent form, as distinguished from real form, should be studied more and more, so as to train towards the artistic methods of form observation. Let each child look at objects as on a vertical plane, and try to copy things as he sees them.

The symbolic ideas of the harmony, economy, and exactness of nature's forms may be pointed out to represent methods and laws of moral growth, and the order of all the material universe; of obedience to law as the condition of truth, and beauty, and harmony. The idea of the universal presence of God, of His thought and love for everything He has created, and is creating and developing, may be used to arouse reverence and love, and an insight into the methods of growth in life of all kinds; all these great fundamental ideas of the soul may be continually nourished by attention to the laws of God, manifest in the material universe, in the smallest equally as in the largest. There is no great and no small, but only that each is perfect, and contributes its perfection to the perfection of all.

Illustrate the idea that all outward shapes of living things are conformed to the inward pattern. The shape of the leaf is conformed to the direction of the mid-vein and its branches; the shape of the fruit is according to the pattern of the blossom or the seed; the shape of the animal is determined by its skeleton and cavities. The body is made more and more to express the spirit; the face and features express the feelings. Conduct and manners are conformed to character.

LESSON

So many examples of lessons on form have been presented in our educational periodicals, and in connection with the department of drawing, that it seems unnecessary to give a detailed course here.

A distinct course of lessons in form includes models of the sphere, cylinder, cone, cube, pyramid. The cylinder is produced by the rotation on its long axis of a rectangular plane; the cone is produced by the rotation of a triangular plane; the pyramid is a cone subjected to equal and opposite pressure on four sides; the cube is a sphere subjected to equal and opposite pressure on six sides. Let the children make all these forms from the sphere.

Show a crystal cube of iron pyrites, or some other mineral. Point out, if possible, lines of cleavage in masses of rock, which illustrate the tendency to crystallize in cubes. Show them how these solid forms or blocks are used in building. Show the cone in nature; the stalactite, icicles, pointed summits of mountains; icebergs; wind-blown sands. Speak of the massive effect of the pyramid in architecture. Pyramids of Egypt. Show the cylinder in elongated vegetable cells, etc.

Study the surfaces of solids; shapes and edges of faces; lines, — horizontal, vertical, oblique, parallel, perpendicular, straight and curved. Study angles; right, oblique, acute, obtuse.

Study curvilinear forms, — circle, ellipse, oval. Study polygons as far as the class can be interested in them through living forms, or crystals; triangles, quadrilaterals, pentagons, hexagons, octagons, etc.

In all the observation work on these forms let the children recognize the forms wherever they see them. In all the expression work let them illustrate the forms by drawing or moulding, or by cutting and folding paper models; as well as by a variety of language lessons involving a clear apprehension of their qualities and elements. Let the children practise measurement in connection with all these forms, and get their dimensions accurately.

Practise design with all these initial forms, always making the

unity of a combination the dominant idea, and subordinating all the several ideas to that unity. Symmetry also is an indispensable feature of right design.

Teachers can easily elaborate courses of lessons after such a plan, to suit their individual wants and resources. It is much better for the teacher not to be held too narrowly to a given pattern and too much detail, for the rule of growth by self-activity applies to the teachers as well as to the scholars, and too minute and invariable direction tends to make the teaching mechanical and lifeless. Every teacher should be original and productive in her work, and formulate it for herself under a free inspiration, so far as a necessary uniformity of courses in the schools will allow.

I should regard the Prang Models for Form-Study, with the Teacher's Assistant in the use of those models, and the Teacher's Manual in Form-Study, as a thorough equipment for this work.

The thought which is constantly given to the drawing-classes by Mr. Hitchings, director of drawing — that drawing is the language of form, and its alphabet, the dot, the straight line, and the curved line, and that its language is universally understood — opens the way to many lessons of practical importance and interest.

SUGGESTIONS FOR LESSONS TO DEVELOP IDEAS OF PLACE

ILLUSTRATE the signification of adverbs of place; viz., here, there, on, under, beneath, in, through, below, above, apart, around, behind, before, right and left, opposite, alternate, etc. These relations of place may be illustrated by the child in pointing out objects so related, in placing objects, or in making pictures which convey the ideas involved, as of a bird *in* a cage, a cat *under* the table, etc. A primer prepared for deaf mutes, by Miss Fuller of the Horace Mann School, conveys these distinctive ideas very clearly, and is a capital model for such lessons.

Ideas of *direction* may be given under the head of *place*. These can be combined with geographical ideas or with work in form. The points of the compass, plans and maps of the schoolroom, or of the street and neighborhood, will provide expression and observation lessons which interest children very much. Many language lessons can be based upon these ideas.

Distance may be made a prominent object of observation; careful measurements will train the hand and educate the eye; pacing off a distance, measuring by the hand or finger, or chiefly with a ruler marked in inches, is excellent practice, and will easily divert a restless child. The sense of hearing can be applied

to *distance* and *direction;* let the children judge by the sound of either a bell or voice, with the eyes closed. Sound, as an element in judging of place, is important, and admits of much experiment with musical tones. Let a blindfolded child try to walk to a place he has seen in the room, or to some one who is speaking; let him find a child who makes some subdued noise. The sense of smell may be applied to direction. Find a flower by its perfume, or judge of its relative distance by the strength of its odor.

The sense of touch may be used alone to define position. This sense, is, perhaps, the most susceptible of cultivation, and the most essential to knowledge. All exercises for the blind would be useful in developing this sense.

Order is necessarily related to place. Putting things in order is a good mental exercise, as well as a good moral habit. Arranging objects in groups, such as pieces of paper by color, size, or shape, makes excellent expression lessons to develop ideas of place. Organized military movements are an illustration of orderly motion as well as orderly place. Let the children place themselves in order, according to size, according to age, according to rank in the class, etc. Making up the Multiplication Table is an exercise of this nature.

Talk of place so as to draw out and make clear all its associated ideas; think of all that enters into our idea of a place to recall it, — ideas of location, surroundings, travel, time required to go from one place to another, time for light to travel, time for sound to

travel; ideas of distance based on the comparative time required for sound and light to travel; the flash and report of a distant gun, of lightning and thunder; time required for the light of stars to reach the earth, etc. etc.

Judge of distance by sight alone. Practical perspective is involved in the relations of place, and can be used as a basis of drawing with the aid of a vertical plane, until the pupil discriminates between his judgment of the proportionate size of objects as affected by place, and his real observation of them by sight alone. Let the pupils observe how distant buildings look on the glass of the window, as if they were painted there, and learn by practice with the stretched line how to see things as they actually appear to the sight alone.

Arrangement is also an element of the idea of place. The arrangement of leaves on a stem, of petals in a flower, of lines or angles in some design, of objects around a centre, — these and many other points may furnish lessons in arrangement both for observation and expression. The place of the various parts of the body and face, for use and for beauty are worth noticing; the classical proportions and artistic measurements of the face will interest the child by way of experiments with a measuring tape. The eyes are half way from the top of the head to the chin; the forehead, nose, and below the nose are of equal length. The head of a grown person is one-eighth his height; the arms, hands, and fingers are of regular proportions to the body.

All the ideas of symmetry and unity in design are connected with place, and too much practice cannot be given for the development of these ideas, which are so beautifully and universally illustrated in the forms of nature, and which symbolize and represent so clearly moral growth; it was the observation of the symmetry of the flower, and the reconciliation of its united opposites which put Froebel in possession of the secret of his educational philosophy. It should always be pointed out that unity and harmony are greater than diversity, and that in any orderly arrangement of forms, the most conspicuous thing should be the harmony and subordination of every part to the central idea which unites them.

A place for everything, and everything in its place. Facts learned and thoughts suggested should be arranged in the mind about a central idea; conduct and manners and feelings, about a central purpose and motive. Love should be the central and harmonizing idea of every thought, wish, and act of our relations to each other, it is an idea which unites us to others; hate divides us from others and sets us in places of unrest and hostility in the world. The idea of direction is one of the most effective in its application to character. Which way are you moving? how is your face or life directed? A very slight difference in direction at the start may make a very wide difference at the end. The switch turns the rails but a very little, but as they go on they diverge more and more; one route may lead to the opposite part of the world from the other, and it is harder and harder to get back to

the place where they joined. One road may start close to another, but one goes to New York and the other to Canada. Two boys may start in life together, but as they go on they separate more and more, till they can never meet. One boy is on the right track, the other, on the wrong track; the difference in direction is the great difference in life.

Ideas of place are preparatory to all study of geography, and may be connected with that and every other branch of natural science.

Expression-lessons may involve movement plays and songs, such as are used already in the schools and kindergarten, and which convey ideas of home and family, of the outside world, of society, of various plants and animals, and of all which connects man with the earth as his home and place of abode.

NOTE. — See "Hand-Book of the Earth," chapters on plants and animals.

SUGGESTIONS FOR LESSONS TO DEVELOP IDEAS OF SIZE

ALL experiments which exercise the senses of sight and touch apply to this subject. Lessons in accurate measurement, with a ruler or tape, or with vessels of dry and liquid measure, and the appropriate material for their use, will be capital for interest, occupation, and training, as well as for laying up facts of size, and standards of comparison.

Compare the size of various objects; give lessons of this kind with small objects, such as papers or blocks for "busy work," lessons with larger objects for class-work. Guess at the size of various objects and then correct the result by measurement.

Practise weighing with scales or a steelyard. Guess at weight by lifting, and verify the result by weighing. Guess at the weight by the eye alone, and verify the result. Judge of size by feeling, without looking. Judge of the comparative fineness of wire or cord by feeling, and of size, by walking around the object.

Judge of the size of things at various distances. How large does an object look to different pupils? How large does the full moon look to each pupil? How large is a horse's head? a brick? a piece of rock? a bowlder? Guess the size of things which you cannot

measure, and see how far various pupils agree. How large is a man's foot, or a lady's hand? Show the pupils a volume called a quarto, an octavo, a duodecimo. Let them learn the various sizes of type, of paper, etc.

Grade objects as to size; a grain of sand, a building, an Egyptian pyramid, various works of architecture, a city, a country, the hemisphere, the earth, the sun, the solar system, the universe; a molecule, an atom, a particle, an organism; an infant, a child, a man, a giant; a whole, a half, a quarter, an eighth, etc. A set of cards for number-work has been prepared by Miss Isabel Shove of the George Putnam School, which are excellent for such comparison of size; they may be obtained of Ginn & Co.

Let the child imagine things on various scales of size; an insect travelling about a tree trunk, a squirrel running through the woods, a horse galloping over the prairies, a caravan travelling across the desert, an elephant in tropical jungles, a whale in the ocean, etc. Let him describe club-moss or the low shrubs of the field as if they were forests, and the insects as if they were proportionately large; or let him imagine men as giants, stepping easily over the hills, etc. Such exercises are good for language-work.

Let him learn that size is altogether comparative. There is nothing great and nothing small, except as measured by some arbitrary standard of comparison. In nature the small is as important as the large, and as perfect in detail, also as necessary in its place and relations. A thought is as important as an act.

SUGGESTIONS FOR LESSONS TO DEVELOP IDEAS OF THE QUALITIES OF OBJECTS

THESE are discovered and tested principally by the sense of touch, as hot, cold; smooth, rough; coarse, fine; wet, dry; soft, hard, etc., but also by taste and other senses, as sweet, sour; bitter, acrid; well, or ill flavored, etc. Many qualities are detected by sight, as dull, bright; coarse, fine; straight, crooked, etc., and a less number by hearing and smell.

All sorts of exercises, in improving the senses and developing the study of qualities of objects, may come into the study of minerals, plants and animals, as well as physics. Horace Grant's "Exercises for the Improvement of the Senses for Young Children" will be found very useful to the Primary School teacher, for use in any exigency, and for the occupation of the children so as to lead to language lessons. I would recommend the teachers to have the little book at hand; it is one of Lee and Shepard's hand-books.

In mineral lessons, the lustre, the texture, the weight, the grain, etc., are to be examined by the senses, also the qualities of various woods and other material. Many things must be determined by handling. The sense of touch admits of a very high development. Tell the class of Laura Bridgman and others who have had no other means of knowledge. Teach the child to

discriminate qualities by each sense separately, and compare his knowledge gained by one sense with that gained by the use of all the senses. Call for anecdotes of the special development of any sense in various animals, such as smell in the dog, sight in the bird, touch in the insect, hearing in many animals. Speak of the development of the organs of sense in various creatures, e.g., the organs of sight of the spider and fly, the antennæ of insects, etc. Let stories of this kind, within any child's experience, be brought and written out, for composition-work.

Let the child try the toughness, the hardness, the resonance, the magnetism, the elasticity, the ductility, malleability of various substances with his hands or tools, or by experiments of any suitable nature. Manual training may come into lessons of this kind with the greatest advantage.

Let the æsthetic qualities of form and color be discussed. Let the moral qualities of conduct in common life be discussed, and stories or actual experience in the schoolroom be used in illustration of all these points.

NOTE. — It is desired that any exercises or course of lessons arranged by any teacher may be sent to the Author, for possible use in further instructions for all the teachers, in Observation or Elementary Science ; also, the names of any books, or material, that have proved useful in such lessons.

PART SECOND

PLANT AND ANIMAL LIFE

ELEMENTARY SCIENCE

THE observation of natural objects and phenomena develops and trains not only the senses but the faculties of perception, of comparison, of classification, and of reasoning; also, the memory, imagination, and taste.

To describe the objects and phenomena of Elementary Science by giving the results of observation, disciplines the powers of expression, training them in clearness, exactness, and completeness, whether in language, drawing, or other forms of expression.

The observation of natural forms and phenomena gives the pupil a systematic habit of thought, leads him to scientific methods of study, and teaches him to distinguish not only difference in degree but difference in kind, the superficial from the fundamental, the individual from the typical.

Every observation should be made an opportunity for logical interpretation, for perceiving cause and effect, and the relation of one fact to another.

The child should be led to observe the beauty and symmetry of a natural form, its adaptation to its conditions and habits, and the correspondence between its functions and its structure.

The contact of the child with nature should be made healthful and strengthening to the moral nature, lead-

ing the thought and feeling of the child to a sympathy with all created things, and to a sense of the presence of the Creator.

The occupation of the mind in its attention to the forms of nature which lie all about us, is a preventive of idleness and immoral or mischievous activities. The occupation of the hands and the senses in both observation and expression gives habits of innocent and useful industry, and educates the social and fraternal instinct, making the child aware of his relations to others, and of his responsibility as a member of society.

Keep alive the child's curiosity in regard to natural objects; impress the pupil with the idea that nature is worth studying. No matter how desultory the lessons, if they put the child into loving communion with nature they achieve their highest object. The attempt to teach any systematic body of facts or doctrines must be subordinate, and approached only inductively.

Pupils should be encouraged to bring specimens of all sorts of natural objects. Each specimen should be the subject of a lesson, if possible.

Judicious questioning should bring out the facts; the teacher should explain, where explanation is necessary, and relate the object to other objects as a preparation for scientific classification.

The teacher should sometimes ask questions which cannot be answered, so as to give an idea of the unfathomableness and manifoldness of nature.

Study at first natural forms and processes as they come to hand, and in their entirety and obvious uses

and relations. Take a specimen of rock abundant in the vicinity, a common plant, a familiar animal, and observe it first as a whole, afterwards in its various parts or elements. Never attack a subject in a way that is opposed to its natural presentation to the child, or offer to the young child's sensibilities such objective study as is naturally distasteful or repulsive, such as dissected parts of animals, or pictures of diseased internal organs and processes of the human body, or specimens of some of the lower orders of life.

Begin minerals by observing a piece of granite, plants by observing a buttercup or dandelion, or a tree familiar to the children, etc.; animals by observing the most familiar quadrupeds or birds about which every child may have something to say and in the study of which he has already an active interest.

Encourage the child to read about the objects he is studying, after he observes them for himself.

If any mineral, plant, or animal becomes incidental to his study of geography, let him take it as a subject of observation, if practicable, either from life, from pictures, or from preserved specimens.

Always study the physical conditions and surroundings of every natural object, also its uses for man, and its place in the order of nature.

Bring in the microscope and the stereoscope as opportunity allows, and encourage the forming of collections and clubs for experiment and investigation.

(Frost's microscope is an excellent one for the schoolroom, being simple, convenient in structure, cheap, and easily managed, as well as available for a variety of

objects. It may be obtained by application to Mr. Stiles Frost, 178 Devonshire Street, Boston. It is used by Master Chase of the Dudley School and Master Clapp of the George Putnam School, for elementary science study in all departments.)

PLANT LIFE

Observation lessons on plant life may be best provided for by boxes of growing plants in the schoolroom, or by the development of seeds in glasses or sponges, on the desk of each pupil. Collections of leaves and fruit in the autumn; of boughs and twigs, or of specimens of woods, in the winter; of leaf and flower buds and plantlets, showing root, stem, and leaves, in the spring; and of flowers in the summer, — will furnish an abundant variety of subjects for observation, and serve to arouse a lively interest in the study of vegetable life. A garden connected with the school is the best of all conditions for observation lessons on plant life, involving opportunity for tending and cultivating the growing plants, with the accompaniment of good physical exercise. Fine specimens of the various grains, of maize, wheat, oats, rice, cotton, grasses, etc., as well as of evergreens, berries, and hard fruits, should ornament the walls of the schoolroom, for decoration and observation, for preparation for geographical study, and for illustration of geographical facts. A few such specimens brought into the schoolroom will soon arouse the interest of children, and open the way to a constantly increasing store gathered by the pupils from perhaps unexpected sources, until a very healthful spirit of emu-

lation in gathering material and of observation in this direction is brought about. It is astonishing to see how soon the wilderness of a city schoolroom will blossom under the inspiration of a few pretty forms of plant life, set before the eyes of the children in an attractive way.

Begin the observation of plant life at any point, or with any material most accessible. With little children it is not necessary to follow a system, but only to lead them to love plants, and to observe them carefully. Never fail to draw out some appreciation of the beauty of form and color presented to the eye; and, later, of the order and design of the whole plant, as well as of its various parts and their uses. Always involve the sympathy and love of children in the study of nature, as such activities educate the æsthetic sense and the faculties of the soul.

If leaves are the subject of study, call attention to the form, the margin, the veining, the stem, the texture, the uses, and the arrangement. For expression lessons let the leaf be described, or drawn and painted, or formed in wax, or cut from paper; an impression of it may be made from a blackened leaf; or let it be pressed, mounted, and labelled. Make some general classification of leaves from the comparisons of the children, as to the veining or other distinctive points. Miss Youmans's Botany is excellent as a guide in this direction.

If the study is of *fruits*, show always the essential relation of the fruit to the life of the plant. Let the children observe the provision for the nourishment of the seed, and the preservation of the plant, as well as for

the uses and enjoyment of man. Use sections of the fruit as illustrations of geometrical forms and elements of designs in drawing. Call attention to the color of fruit, to its juices and flavor, to the adaptation of its means of support to its position on the ground or in the air, to the pendent grape and pear, to the closely held stem of the apple and peach, to the heavy fruits which lie upon the ground, slightly connected with the stock, etc. Take *seeds* as a study; assort them, and learn something of their different conditions of growth; for expression lessons this assortment, and the making of cases to hold the seeds, added to the usual work in language and number, will familiarize the child with the subject, as well as give opportunity for manual training. Some ornamentation with seeds, stringing and wiring with watermelon, flax, or other seeds, may be useful as "busy work;" little children will delight in handling various seeds and putting them up in packages which may involve counting, or in learning how to plant seeds, or in watching their germination in glasses or sponges, etc.

Some ideas may be given to children of the use of the various parts of the plant, by directing their observation to those special parts, and their adaptation to those uses: for example, the wings or feathery parts of seeds, to waft them abroad; the blade of the leaf outspread to the action of the sunlight and air, for chemical action and purposes of growth; the curling tendrils, for clinging; and the roots so formed as to secure the stability of the plant in the soil, and to gather up the elements of the soil through the root hairs for building

into the fibres of the plant, so that animals needing those elements for sustenance, may find them in the food which plants provide. A chapter entitled "The Carrying Trade," in Miss Andrews's book, "Stories of Mother Nature," is very interesting and clear on this subject.

"The Science Guide, No. II," in the Natural History Series, published by Ginn & Co., Boston, is an excellent manual in conducting observation lessons on plant life. A little book by Miss Jane Newell, "Outlines of Lessons in Botany," published by Ginn & Co., develops the work in a very interesting and practicable way. In the preface the author says what I would emphasize very strongly in regard to both plant and animal study: "The method of beginning with the simpler forms of life is one that appeals to the scientific tendencies of the day. It seems logical to begin with lower forms and work up to the higher. *But this method is only suitable for mature minds.* The study of any Natural Science by the young, should be the observation of the most obvious things about them, the things which they can see and handle, and experiment upon naturally without artificial aids." I would also quote, for the purpose of indorsement, another paragraph from this preface, viz.: "There is no real division between animals and plants. We try to classify the objects about us in groups, according to the closeness of their relationships, but we must always remember that these hard lines are ours, not Nature's." As illustrative of this truth, we can show a child how a plant, as well as an animal, feeds and breathes; how circulation is carried

on ; how, in some cases, a plant feels, as in the sensitive plants, and digests, as in carnivorous plants, and seems to exercise choice, as in climbing plants ; how regular movements of some organs, as tendrils and stems, occur very much as in animals ; how the hairy organs of some plants act as the tentacles of an animal, etc., etc., as opportunity of such observation may be provided. Every child will attend with sympathy and eagerness to all observations of this kind, and expression lessons in this connection may be movement plays, or involve personification and dramatization, so delightful and natural to children.

I would mention as good subjects for germination in the schoolroom, the seeds of morning glory, sunflower, bean, pea, red-clover, flax, corn, wheat and oats, packages of all of which can be obtained of Joseph Breck & Son, Boston, Mass., for fifty cents, sent by mail, postage paid. The germination of these seeds in the schoolroom will furnish observation lessons enough for three years of Primary School work in this branch. The soaked seeds may be first examined, and the various kinds compared ; afterward, the order of growth, and the organs as they develop may be observed. Gray's "Text Book on Botany" will be all sufficient for the teacher's use in conducting these lessons.

In the winter each child can be provided with a branch of a tree or shrub ; he should be led to notice any points of likeness or unlikeness in various kinds of branches ; elms, maples, ash, oaks, basswood, beech, poplars, willows, walnut, butternut, hawthorne, and evergreens are suitable. Let the children observe the buds,

their situation and order; rings left by the bud scales, the age of the branch as shown by these rings; the bark; the under-wood; the internal structure of the buds; the little dots which show the breaks where the inner bark pushes through, and which make a place for the gases to pass in and out. The children may use the knife in laying open and studying the buds, and in cutting sections of the branch for specimens of the wood. A great deal of manual skill, and use of tools, may be encouraged in preparing a variety of sections of as many kinds of wood as possible, thus collecting a museum of useful and ornamental woods of many sorts, as illustrative of geographical location, of manufacturing value, and of beauty of texture. The uses of woods may be studied in this connection. Each child should have the liberty of keeping his own collection.

Some excellent objective material may be found at the Boston School Supply Co., 15 Bromfield Street, Boston, in the shape of cards illustrating departments of the mineral, vegetable, and animal kingdom, on which are mounted specimens of various kinds showing especially the uses of the natural object studied. These may be used to some extent as models of what the pupil may do for himself, or for furnishing the schoolroom; for in all cases the pupil should be stimulated to construct for himself his illustrations, or record his own observations; but if the teacher desires ready material, sections of several different woods may be obtained in packages for one dollar, from C. W. Spurr, 35 Bedford Street, Boston, with duplicates enough for an ordinary class.

When flowers are studied, I would advise taking some typical flower as representative of a family, or a variety of plants belonging to the same family, so that characteristic features may be discovered, and the children may learn to recognize prominent families of plants by the flower. I would avoid technical Latin terms, but try to use terms indicative of the specific qualities of the subject, and which may be suggested by the children: as to call the calyx, the cup; the stamens, the seed-givers; the pistils, the seed-holders; the corolla, the crown cup; the receptacle, the seed-box, etc., etc., unless the children desire the harder words.

Below is a plan of lessons as furnished by Miss Huston, of the George Putnam School, from her own experience, and which gives an excellent example of working up observation on one family of plants. The class was a grammar class, first grade; but the method may be the same, less elaborately carried on in a primary class.

Next to actual plant forms, growing and healthy, pictures are useful for study. In this kind of work nothing is better than "Prang's Natural History Series," which contains packages of twelve colored plates representing shapes of leaves, shapes of roots, shapes of flowers, the rose family, the pink family, the lily family, and poisonous plants, each with printed directions for teaching, by N. A. Calkins, a well-known practical educator. A manual to accompany the series, by the same author, may be obtained for fifty cents. Some very fine large plates for the schoolroom walls may also be obtained of the same publishers.

It is very much to be hoped that actual gardens may be provided in our school-grounds, and the pupils encouraged to care for them. There should be window-gardens, or at least seeds, leaves, and stems, provided for class observation. Certainly, trees and shrubs should be grown for ornamentation and study near the school premises. Such material is more essential than books. Master L. M. Chase, of the Dudley School, writes very pertinently: —

"School-grounds should be separated into two distinct portions: one for an outdoor gymnasium or playground, the other devoted to turf, trees, shrubs, flowers, and walks. Pupils should be early led to take an interest in the cultivated part of the grounds. Rightly improved, trees, vines, shrubs, and flowers can be made most important auxiliaries in instructing and developing our young children, furnishing means for numberless object lessons even in our primary schools."

It is probable that with the extension of our public parks, the opportunities for observation of plant life will soon be multiplied, and that some systematic appropriation of such opportunities will be accomplished for our public schools.

A little book, quite inexpensive, called "Flower Object Lessons," translated from the French of M. LeMaout by Miss A. L. Page, of the Cushman School, Kindergarten, to be obtained of Miss Page, gives about twenty excellent models for studies and observation by little children. I think it especially adapted for sight observation lessons. The work of LeMaout is a truly

elementary one, of nearly six hundred pages, in a simple and delightful style, with fine large plates.

There are multitudes of attractive books on flowers or trees which may be used for reading with children, to feed their interest in the subject. The teacher will find "Emerson's Forest Trees of New England" a most valuable work for reference.

In the expression lessons, color work upon outline drawings of flowers, or sewing on perforated cards in forms of fruit, leaves, or flowers, as well as making paper flowers or wax flowers, will be very engaging; the line of instruction in drawing may be a development of this work, especially in the line of ornamental design.

In the examination of flowers, bring out the most important and typical points. In the lily family, the parallel-veined leaves, the arrangement of parts of the flower by threes: three inner petals, three outer petals, three inner sepals, three outer sepals, six stamens, a pistil with three divisions, and a seed-vessel with three cells. The dog-tooth violet, the white lily, the yellow lily, the tiger lily, the field lily, the lily of the valley with united petals, the hyacinth, the tulip, and others, can be studied and described, drawn and colored, pressed and mounted, until the family is well understood. So with the rose family, of which it is easy to find blossoms in the spring and early summer; as it embraces not only the wild rose, but the blossoms of the apple, pear, peach, cherry, strawberry, blackberry, raspberry, and other varieties. Bring out in this family, the five rounded petals, with five sepals, many stamens,

which develop into petals under cultivation, and the five compartments of the seed-vessel; also the thorns and briers which characterize the stems of many varieties, and which protect the flowers from plucking; the delicious fragrance of the flower, or flavor of the fruit, the color and beauty of the rose, and of the apple-blossom, etc.

Studies like these, of different families, by observation of their typical features, seem to me more natural to little children, and more productive of love of plant life, so as to affect their future interest and study, than a more analytical observation of the lower forms of vegetable life as laid down by some of the scientists who have worked in the line of elementary study. Let the feeling and happiness of the child enter into every part of this work; and let plant forms speak to him of divine goodness, and an ever-active creative love, which embraces all forms of life, conscious and unconscious. Many beautiful poems of flowers and plants can be found for little children in the best literature. Verses can be recited, and plays and cantatas of flower-impersonations acted and sung. Parables for a moral lesson from plant life are very beneficial in this connection, as they convey the symbolic lesson, and show how plant life illustrates the law of spiritual life.

(See "Plant Lessons and Parables," in "How Shall My Child be Taught," and "Flower Songs and Plays," in "Natural History Plays," published by Lee & Shepard.)

Children should be encouraged to give flowers to the sick, or to those deprived of them by circumstance; and

to raise at least one plant for themselves which shall enable them to have flowers to enjoy, or to give, at all seasons. The Department of Agriculture at Washington gives away packages of seeds of flowering plants, on application to the secretary.

AN ATTEMPT TO UTILIZE OUTDOOR MATERIAL IN THE SCHOOLROOM

A COURSE OF LESSONS BY MISS K. W. HUSTON, OF THE GEORGE PUTNAM SCHOOL, BOSTON

ONE morning, in the early part of October, the teacher showed the class some pressed flowers, and spent a few minutes in talking about them. Among the specimens were nine species of our native asters; and as these flowers were then blossoming in profusion, it was suggested that the pupils should bring in, at noon, as many kinds as they could find, and compare them with the dried specimens, which were all correctly labelled.

Before two o'clock, quantities of the flowers had been collected and were on exhibition in the schoolroom. They comprised eight species, as follows: *aster cordifolius*, *a. linariifolius*, *a. multiflorus*, *a. Tradescanti*, *a. diffusus*, *a. puniceus*, *a. undulatus*, and *a. corymbosus*. These names were written on the blackboard.

When the regular hour for derivations and spelling arrived, the teacher wrote on the board, "1. *folium*, a leaf." The pupils were then asked to find derivatives from this root; and as these were given they were written in their proper places.

The root next selected was *cor*, and its derivatives being given, the word *cordifolius* was translated by the pupils, while specimens of *aster cordifolius* were shown.

Linea multus, and *flos*, were treated in the same way, specimens

of the different asters being examined and compared. The blackboard work now stood as follows: —

1. *Folium*, a leaf. Foliage, foliate, folio, foliaceous, foliation.
2. *Cor* (*cordis*), the heart. Cordial, cordate, core, courage.
   Cordifolius, heart-leaved.
3. *Linea*, a line. Lineage, lineal, linear, lineament, line.
   Linariifolius, linear-leaved.
4. *Multus*, many. Multiply, multitude, multiplicand, multiped, multiplied.
5. *Flos* (*floris*), a flower. Floral, florist, florid, Florida, Flora, Florence.
   Multiflorus, many-flowered.

After this work had been copied in the blank books, the pupils were told the meaning of *aster*, and the drawing of an aster, greatly enlarged, was placed upon the board, and beside it, a many-rayed star. The drawings were left without comment, that the children might see the analogy for themselves.

The next morning several specimens of *aster linariifolius* were brought in, and were accepted by the teacher without reference to peculiarity or name. At five minutes past nine, slips of paper were distributed to the pupils. The teacher then said, "I am going to show you an aster which has just been given me. Look at it carefully, and see if it belongs to either of the species whose names are on the board. If you think it does, write the name of the species on your paper, and under it write the meaning of the name." When the papers were collected, it was found that thirty-four out of the thirty-eight contained the right name, its definition being given in various ways: "linear-leaved," "line-leaved," "leaves like lines," etc. The time occupied was ten minutes. One species of aster had been learned intelligently.

The children now attacked the other long names for themselves, both at recess and after school, and examined and compared the asters which had been brought the day before. After school that night a party was formed to visit Franklin Park and collect specimens for pressing; and cries of "This must be *cordifolius*! Look at the leaves!" "Here's one with a red stem! Is it *puniceus*?" "I've a whole handful of linear-leaved. I'll 'divvy'!"

—showed that the several species no longer looked to the children exactly alike, and also that some of the specific names had ceased to be mere combinations of letters. On this excursion another species, *aster patens*, was added to the list.

At another time, in a ten minutes' talk in the schoolroom, the pupils were asked to think of some "rayed" flowers besides asters. They named the daisy, sunflower, dandelion, chiccory, and fall dandelion (hawkbit). A proof that children naturally notice family resemblances was found in the fact that up to this time many of them had called the chiccory a "blue daisy." The names of these flowers were written on the board under the heading, "Composite Family." After learning the force of "composite" as applied to asters, the children took much interest in examining single flowers under the microscope; and by the same means the achenia of different asters were compared. Other members of the Composite Family were found in the may-weed and the daisy fleabane; the former being called by the children a daisy, and the latter, an aster. Nothing seemed to excite more pleasure in the pupils' minds than their growing ability to call the various flowers by their true names, after realizing the mistakes, like those just mentioned, which they had made.

Other excursions to the woods resulted in the finding of *aster longifolius* and *a. macrophyllus*, and familiarized the children with the different asters which had been found before. *Aster laxsus*, a beautiful variety of *a. longifolius*, was brought by one of the girls in quantities sufficient to enrich all the collections. Some fine specimens of *a. lævis* and *a. Novæ Angliæ* were also given to the children.

In selecting the asters for pressing, care was taken to obtain the leaves nearest the root, as these are usually the most characteristic. After the plants had been pressed for about two weeks, they were mounted separately on sheets of drawing paper, each specimen being held in place by strips of gummed paper. In the lower right-hand corner of each sheet were written the common name of the flower, the family name, specific name, the locality where it was found, and the date. The mounting and labelling were done by the pupils, many of the specimens being very gracefully

arranged. The work was sometimes done at home, sometimes in the schoolroom after school hours, and great interest was always shown over the results.

The object of this work was twofold : —

First, to lead the children to take an intelligent interest in the wild flowers by which they were surrounded, in the hope that they might feel a desire to pursue the subject farther as they had opportunity. It was believed that the study of plants, as they were found growing in the fields, would induce greater interest than the study of seed-vessels in the schoolroom ; and that an acquaintance with the fall flowers, kept up through the winter by reference to mounted specimens, would lend to the coming of the earliest spring flowers a charm which could be experienced in no other way.

Second, to vitalize the work in language and drawing by the use of material in which the children felt a personal interest.

OBSERVATION OF ANIMAL LIFE

In studying animal life, it is hardly possible to give opportunity for much observation of living subjects in the schoolroom. Familiar animals may be observed by the children out of school, and the results called for in school; or one or two specimens may be brought into the schoolroom for general observation. When it is possible to take the children to a park or garden, to the fields, woods, or seashore, and secure careful observation of life in its natural surroundings, the best methods may be pursued. Once a year the children should visit a menagerie or zoölogical garden or museum with a teacher, to observe forms which are not familiar, and enlarge their acquaintance with animal forms and habits, as well as to stimulate their love of nature. Stuffed birds and animals serve next in value to living forms for schoolroom work. Shells and dried specimens may be useful for collection and study. Pictures are a very good sequel to real forms, and may be carefully observed. It is important to have accurate and clear pictures, many of which ought to ornament the walls of every schoolroom. Prang's charts and Natural History plates are available and satisfactory here. Many of the geographies and readers used in schools have excellent pictures of plants and animals. Collections of nests, eggs, feathers, scales, and any well preserved specimens of plant or animal fibre or manu-

facture, are interesting for the schoolroom, and will be easily gathered by an enthusiastic class. All kinds of observation are included in the application of the five senses to the various subjects in elementary science, and questions which direct the sense-activities to each subject will bring out all the facts to be gained. Appended is a variety of questions suggestive of the work aimed at in observation lessons for primary and grammar classes.

The microscope should be used sparingly with young children, as it strains the eyes, and fatigues the nerves. The lessons should be short and vivacious.

QUESTIONS ON SUBJECTS OF OBSERVATION

In regard to every subject of observation let the child answer the following questions where they can be applied. What is its *color*, shade, or tint? its general color, and the color of its several parts? is it harmonious or contrasted in color? what is the color of its surroundings? what other things are of the same color? is it pleasing in color? does it change in color? how? what is its shape? what is the *form* of its outline? what is the form of each part? is it even or crooked in form? regular or irregular? symmetrical or otherwise? what is the form of its framework? what is the *arrangement* of its parts? what is its plan of arrangement? how are the parts related to the whole? what seems like it in form? in arrangement? why is it so shaped? of what advantage is its plan of arrangement or its shape? how would you change its form? is its

form beautiful or ugly? is it well-proportioned? what is the main *direction* of its lines? is it upright or prostrate? leaning or firm in position? is it high or low? are its parts opposite or alternate? on one side or on two sides, or on more than two sides? are they arranged around a centre, or in parallel lines? is it near or far? is it still or moving? does it change in shape? how? what is its size? is it large or small? does it grow or dwindle? how long is it? how wide? how thick? does it vary in size in different parts? what is the size of each part as compared with the whole? what is the *distance* of any part from the centre? of one part from another? of the object from some other object? (measure accurately all these distances) does it lie, stand, lean, fall, move? how does it move? in what direction? how fast? by what means? for what purpose? does it carry or lead or push or lift or drag or toss or follow anything else? does it take anything else within itself? does it throw anything outside of itself? is it alive? does it know? does it think? does it choose? what can it do? what can it become? how does it live? what are its organs? how are they fitted to each other and to the whole? what does it need? where is it found? how is it fitted to its place and for its place? does it show love or hate? is it safe to handle? how does it keep in its place? how does it change its place? what *parts* of it cannot be moved? what are the front parts? the hind parts? the upper parts? the lower parts? the middle parts? how many parts has it? what is the highest part? why? what parts are alike? how are the parts adapted to their uses? where is its home?

when does it change its home? in what surroundings does it live? does it stay in its home? has it *odor?* what kind of odor? (agreeable or disagreeable? sweet or sour? pungent or mild?) what other thing has the same odor? has it a strong or delicate odor? is the odor penetrating? is it easily driven away? how far can you smell it? what is its *flavor?* sweet or sour? bitter or acrid? what flavor is it like? is it strong or weak? delicate or coarse? pleasant or not? is it a simple or a mixed flavor? is it a healthful or unhealthful odor or flavor? does it make any *sound?* is the sound harsh or soft? is it high or low? loud or gentle? musical or not? is it steady or broken? is it prolonged or quick? is it monotonous or varied? is it sharp or full? is it a cry, or a song, or a wail, or a bark, or a mew, or a bleat, or a low, or a neigh, or a roar, or a growl, or a grunt, or a squeal, or a whistle, or a scream, or a piping, or a chirp, or a cackle, or a quack, or a gobble, or a cluck, or a peep, or a rattle, or a whir, or a clapping, or a drumming, or a scraping, or a trill, or a call, or a bellow, or a howl, or a whine, or a lisp, or a whisper? is it a pleasant sound? what sounds are like it? is it frightful? is it attractive? describe it; does it swell or die away? has it rhythm? what is its range from high to low? is it music? can you tell how far off the sound is? (try it) how does the object *feel?* is it rough or smooth? dry or wet? soft or hard? flat or uneven? how much higher are some parts of the surface than others? how uneven is it? how steep? is it elastic? is it brittle? is it tough? is it strong? what is its *texture?* is it loose or close? is it easily pulled out? is it easily beaten

thin? does it vibrate readily? is it sticky? is it glossy? is it silky? is it furry? is it prickly? is it knobby? does it bound? is it heavy? does it roll? does it skip? does it strike? does it rub? is it hairy? is it feathery? does it float? does it swim? does it fly? does it run? does it jump? does it attract steel? is it magnetic? is it watery? is it damp? is it *liquid* or *solid?* is it like air or steam? is it dull or shiny? is it warm or cold? does it glow or burn? is it icy? is it transparent? is it opaque? will light shine through it? will objects show through it? will it reflect like a mirror? how soft or hard is it? why is it soft or hard? what makes it so? for what purpose? *compare* various objects as to color, size, arrangement, number, form, and all qualities perceived by the senses. Make lists of those that are alike in each department of observation. Compare as to needs, causes, uses, activities, processes, and results. Compare means of acting, organs of activity, ends of activity, and adaptation to place and work or conditions of life. Compare the various forms of plant or animal life as to each particular organ and function: the tongue or the teeth, the toes or the limbs, the root, the leaf, the flower, the fruit, the seed, the stem. Ask questions as to origin, growth, and preservation of life.

Let the child express his thought in words, oral and written, in complete sentences, and well connected description; let him draw, color, and mould simple forms of plants and animals, or make impressions of and mount such plant forms as are practicable. Let the child imitate in various ways, and play and sing about all the plant and animal forms he can observe. Let

him cut patterns of them from paper or wood; let him work them with the needle, paint them, or make designs by combining them into patterns.

Games and personifications can be carried out by the class in concert, poems recited or gifts presented expressing mutual delight and kindness, and embodying the facts of observation in a lively manner.

The children can tell stories of plants and animals, make collections, take excursions for observation, keep pets, and watch over all the life they see, feeling that it is in their care.

See "Natural History Plays," published by LEE AND SHEPARD, Boston.

MODEL LESSONS BY MISS J. M. ARMS

THE CORAL ANIMAL

SPECIMENS and apparatus for a class of fifty children: Fifty single skeletons of the Galaxea coral; fifty small fragments of the same, each consisting of three or more skeletons; a model representing the living animal. (This model can be made of red pressboard and white pasteboard. It is only necessary to make the body-cavity, with its red and white partitions; as the disk of the model of the sea anemone, with its tentacle and sac, can serve for the model of the coral animal.)

REFERENCE BOOKS

"Guide for Science Teaching," No. 4, Mrs. Agassiz; "Guide for Science Teaching," No. 5, Hyatt; "Seaside Studies in Natural History," E. and A. Agassiz; "Corals and Coral Islands," Dana; "Atlas on the Report of Zoöphytes," Dana.

LESSON I.

LESSON ON THE CORAL ANIMAL

The teacher holds one of the single skeletons in her hand.

Teacher. "What is this specimen? Who can tell?" *Answer.* "Coral."

Teacher. "Bearing in mind that coral is a part of the coral animal, how many can tell what part?"

The children have taken the lessons on the anemone, and are, therefore, ready with the answer, "The skeleton."

Teacher. "Looking at your skeleton from above and below, does it remind you of anything you have seen?" The teacher waits till every hand is raised. *Ans.* "It reminds me of the body-cavity of the sea anemone."

Teacher. "Having seen this resemblance, will you describe your skeleton?" *Ans.* "It is long and tube-like." "It is white." "Mine is larger at the top than at the bottom." "Mine is curved like a cow's horn." "It is hard like stone." "It has lines on it." "It has something on the outside that looks like white sponge, only it is harder." "Mine is like a cup with walls inside of it." "The walls are long and short." "The walls are not in pairs." "Some of the walls join in the middle, and make a solid-looking thing; above this there is a little deep place."

Teacher. "Now we will take the coral animal. I cannot show you living coral animals, for the same reason I could not show you living horny sponges. How many remember the reason?"

Teacher. "Where are the warmer waters?"

The children point out the homes of the coral animals on the map.

Teacher. "When we cannot have the living animal, what may we substitute in its place?" *Ans.* "A model."

By means of the model the children describe the coral animal. "It is round like a tube." "It has a mouth." "It has feelers around the mouth." "The mouth leads into a sac." "The sac hangs in the middle of the body." "The sac leads into the body-cavity."

Teacher. "Remembering that the red press-board represents

flesh, describe the fleshy parts of the body-cavity." *Ans.* "The body-cavity is divided into rooms by walls." "The walls are long and short." "They are in pairs." "Six pairs of long walls reach the sac, six pairs of shorter walls run in two-thirds of the way."

Teacher. "What has the coral animal that the sea anemone has not?" (The teacher waits patiently for the answer, knowing that time is required for every science lesson.) *Ans.* "It has a white wall that goes around the body, with flesh on either side." "It has single white walls that run in from the round wall." "There is one single wall between every pair of fleshy walls."

Teacher. "What do the white-paper walls represent?" *Ans.* "The white, stony walls." "The skeleton." The children change the drawing of the cross-section of the body-cavity of the anemone (see Guides No. 4, No. 7), made in red chalk, with a drawing of the body-cavity of the coral animal, using white chalk for the skeleton (see Guide No. 5, Fig. 24).

Teacher. "When the animal dies, the fleshy portion passes away, so what remains?" *Ans.* "The stony tube with its walls." "The skeleton."

Teacher. "Now look at your other specimen. What is it?" *Ans.* "Several skeletons fastened together."

Teacher. "From your lessons on the sea anemone can you tell how these skeletons happen to be together?" *Ans.* "The animal budded."

Teacher. "Did the buds go away?" *Ans.* "No; they stayed together."

Teacher. "What does this blackboard drawing represent?" (See Guide No. 5, Fig. 25.) Children describe drawing.

Teacher. "The coral animal not only buds, but also makes eggs. What do you see between the skeletons?" *Ans.* "A white, spongy-looking substance."

Teacher. "This is formed in a layer of flesh that extends between the coral animals, as shown by the drawing on the board." (See Guide No. 5, Fig. 23.)

Now that the children are familiar with the coral animal, they compare it with the sea anemone. By questions, which limited space will not permit us to give, the teacher draws from the chil-

dren the following resemblances and differences: Both the sea anemone and coral animal are salt-water animals. Both have a tube-like body, a mouth surrounded by feelers, a sac hanging in the middle of the body, a body-cavity divided into rooms by fleshy walls which are in pairs. Both have six pairs of long, fleshy walls, which join the sac, and other shorter pairs. Both bud and make eggs.

The coral animal lives only in warm water. It is smaller (judging from the size of its skeleton) than the anemone; it makes a skeleton, and the anemone does not.

The children draw the single skeleton from the side and from above. The teacher then asks for a written description of the coral animal, beginning with the skeleton.

A CORAL SKELETON. DESCRIPTIONS BY PUPILS

"This skeleton is tube-shaped, and is rounded on top. There are twelve long, stony walls. The outside of the skeleton is lined, and the inside is smooth. The lower part is like a sponge, for it is full of holes and tubes (?), the upper is much like a sea anemone. This piece of coral has a great many other pieces around it. In the sponge-like part there are seven little bits of ones embedded in it so you can hardly see them. On some of the larger pieces the top is larger than the bottom, and on others the bottom is larger than the top." (Child of about ten years of age.)

"The coral animal is usually very small, sometimes not larger than the head of a pin, and at the very largest is about as big as half of a child's little finger. First in its structure comes its mouth, which, like the sea anemone's, is surrounded by little feelers. Then comes the stomach (?), which is just like a little bag. Then comes the body-cavity, and that is very funny, indeed, in its arrangement. There are little walls, some of flesh, and some of a hard, stony matter. The walls of flesh are joined on to a little wall of flesh, which covers a wall of bone (?). The cells (?) of bone or lime are joined on to a wall of lime, which is covered with the wall of flesh. Then there is another thing which makes the coral animal different from the sea anemone: it is their size, which I have mentioned before. I should think that, maybe, the

coral animal is some relation to the sea anemone, as cats are to tigers, or monkeys to baboons. The color of my coral animal (?) is dull, dirty white at the bottom, greenish gray in the middle, and pure white at the top." (Girl of about eleven years.)

"The skeleton of the coral animal is round, tapering towards one end. The size is five-eighths of an inch long, and about two-eighths round (?). The walls go towards the centre singly, first a short and then a long one. In the skeleton I am looking at I can count twenty. The outside of the skeleton is rough. The shape of the body is round and tube-like. The mouth is at the top of the body, and leads into the sac. The shape of the sac is bag-like. There is a hole in the bottom of the sac that leads into the body-cavity. It is below the sac." (Boy of eleven years.)

LESSON II.

CORALS

Specimens and apparatus for a class of fifty children: Fifty small specimens of the Finger Coral (*Madrepore*), and of the Sea-fan (*Rhipidogargia*), single specimens of the Porites and Red Coral. These are some of the commoner corals which the teacher frequently owns, or the children bring to the school. Each child has a small piece of the sea-fan.

Teacher. "What is the shape of this specimen?" The teacher holds a perfect sea-fan before the class. *Ans.* "It is flat." "It is broad and round."

Teacher. "Of what does it remind you?" *Ans.* "A trellis." "A sieve." "A network."

Teacher. "Of what does its shape remind you?" *Ans.* "A big leaf." "A fan."

Teacher. "As it somewhat resembles a fan in shape, it is commonly called the Fan Coral. Describe your specimens." *Ans.* "Mine is yellow." "Mine has little holes like black dots."

Teacher. "What do you see on the edge." *Ans.* "I don't see anything." "Something black." "Brown wires."

Teacher. "Those of you who have a knife scrape off some of the yellow portion. What is left?" *Ans.* "A brown fan."

Teacher. "This 'brown fan' is the skeleton, and the yellow part is the dried flesh. What should you think the skeleton was made of?" The children have taken the lesson on the sponge and coral animal, so they answer, "Of a horny substance."

Teacher. "What do you think the holes are that you see in the dried flesh? Those who think they know raise the hand." Many of the hands are not raised, so the teacher asks the children to look at the diagram of the red coral.

Teacher. "What have we here?" (Pointing to the single coral animal attached to a rock in one corner of the diagram.) The children describe the animal as having red flesh, and eight white, fringed feelers.

Teacher. "And what have we here?" (Pointing to the group of animals near the single one.) *Ans.* "Three or four coral animals."

Teacher. "Why are these found together?" *Ans.* "The animals budded."

Teacher. "And now what have we here?" (Pointing to the large branch.) *Ans.* "Hundreds of coral animals."

Teacher. "Are there hundreds? Try to be accurate." *Ans.* "There are many coral animals."

Teacher. "Good. What is the color of the flesh?" *Ans.* "Red."

Teacher. "Do you see the feelers of all the coral animals?" *Ans.* "No; some are drawn in."

Teacher. "What do you see in the middle of the branch?" *Ans.* "A round, red thing." "A red stem with cigars around it."

Teacher. "Do you *know* these are cigars? Tell only what you know." *Ans.* "A red stem with tubes around it."

Teacher. "Good. This red stem is the beautiful red coral out of which jewelry is made." (The teacher shows a specimen of red coral.) "Now let us suppose that this branch, with its living animals, is taken from the water; that the animals die, and the flesh dries; what should we have left?" *Ans.* "A stem with dried flesh."

Teacher. "What should we see in the dried flesh?" The little children eagerly answer, "Little holes where the animals were."

Teacher. "What are the tiny holes in the yellow flesh of the fan coral? I expect to see every hand. You may answer in concert." *Ans.* "The holes are where the living animals were."

The children now compare the red coral, as shown by the diagram and a single specimen, with the sea-fan. They say that "both have a skeleton in the middle, with flesh around it." "Both are made by hundreds of little animals." "Both are more delicate than the Galaxea or Finger Coral." They say that "the skeleton of the red coral is stony and red, while that of the finger coral is horny and dark brown." The children draw and explain the sea-fan. They then write a description of it, and afterward compare the red coral with it.

If time permit, another lesson can be given on the Organ-pipe Coral (*Tubipora*), in which the same method can be applied.

After the written work is finished, the teacher shows the children other kinds of corals, such as the Brain, Mushroom, and Astrea, which they will study when older. She takes them in imagination to Florida, the coral State, and to the West, the land of fossil coral. Then, with them, she sails away to the Coral Islands of the Pacific Ocean; and when, with wondering eyes, they ask her, "How do such little animals make such big rocks?" "Why are the Coral Islands like rings?" "What makes the sea so smooth inside the ring, and so rough outside?" she tells them that these are problems for them to work upon in coming years.

LESSON III.

STARFISH

The teacher draws upon the children's knowledge by asking the following questions: "Is the starfish a land or water animal?" "Where have you found starfishes?" "What is the color of the living starfish?" "Why do you suppose it was called a star?" The children guess that it was called a "fish" because it was found in water; but the boys do not think this a good reason.

Teacher. "Give some other name for the starfish." *Ans.* "Water star." "Pretty star." "Ugly star." "Sea-star."

Teacher. "Have we a living sea-star here?" *Ans.* "No."

Teacher. "Then what part of the animal have we for study?" *Ans.* "The skeleton."

Teacher. "Is it an external or internal skeleton?" *Ans.* "It is on the outside."

Teacher. "Those of you who have a knife scrape the outside of the skeleton. What do you find?" *Ans.* "Sort of a skin."

Teacher. "Therefore we can say the skeleton is covered by a skin. Where do you suppose the soft, fleshy organs are?" (The teacher shows the dried preparation of the skeleton, with the internal organs taken out.) *Ans.* "They are inside."

Teacher. "Into how many parts is the skeleton divided?" *Ans.* "Five."

Teacher. "Each of these parts is called an arm. Are all the arms of equal length?" (If the specimens are typical, the arms will be of nearly equal length; but the teacher can show specimens with one, two, or even four short arms.) "Why do you suppose the sea-star has one arm shorter than the others?" *Ans.* "I guess it got born so." "I don't believe it did. I guess the arm got bitten off, and another tried to grow."

Teacher. "If we lose an arm can we make another grow in its place?" *Ans.* "No."

Teacher. "So you see the sea-star has the advantage over us in this particular. Are the two sides of the skeleton alike?" *Ans.* "One side has a hole in the middle, the other has not."

Teacher. "Place your specimens with the side having the hole downward. Now point to the upper side or back. What do you see all over the back?" *Ans.* "Prickles." "Little yellow stumps."

Teacher. "We will call these spines." (The children describe the spines as short, blunt, and not movable.) "What else do you see on the back?" *Ans.* "A little round thing."

Teacher. "Describe this organ." *Ans.* "It's an eye." "It's a mouth."

Teacher. "Are you *describing* the organ?" *Ans.* "I know it's an eye."

Teacher. "How do you know it, Jack?" *Ans.* "I guess I know it."

Teacher. "Is guessing the same as knowing? Can you prove that the organ is an eye?" *Ans.* "Well, no."

Teacher. "Then will you describe it?" *Ans.* "It is yellow. It has no spines on it. It has lines. It is at the junction (a favorite word of Jack's) of two arms. I have seen it right in the middle of the back."

Teacher. "Are you sure, Jack?" *Ans.* "I think I have."

Teacher. "And is thinking the same as knowing?" *Ans.* "Well, if I find a starfish next summer with the yellow spot in the back, then I shall *know*, and I will send the starfish to you."

Teacher. "Very good, Jack. Then we shall neither guess nor think, but know that you have made a discovery." (Jack has not yet found such a specimen as he described.)

Teacher. "Having observed the little round organ, will you tell me now what is this object?" The girls are quick to answer, "A sieve."

Teacher. "Let us see what work the sieve performs." (The teacher places the sieve over the tumbler, and pours the water containing foreign particles into it.) "What is the use of the sieve?" *Ans.* "It lets the good water go into the tumbler, and keeps out the stones."

Teacher. "Let us imagine that the sieve is reduced in size, and made of fleshy and stony matter, instead of wire and wood; then let us suppose it is placed at the angle of two arms, what would it still be, Jack?" *Ans.* "A sieve."

Teacher. "And what would be the use of the sieve?" *Ans.* "It would let the good water go into the body of the starfish, and would keep out the animals and sticks."

Teacher. "Then is this sieve an eye, Jack?" Jack smiles.

Teacher. "Now look at specimen No. 2. What is it?" (The teacher waits till every hand is raised.) *Ans.* "It looks like a piece of the back."

Teacher. "Describe this piece." *Ans.* "It is made of little bones with skin between them."

Teacher. "We will call these 'bones' plates. How are these

plates placed together?" *Ans.* "They are in rows." "They are not in rows, they make a network." There is usually a difference of opinion on this point; but when the teacher shows the whole back of the starfish (as seen in the dried preparation of the skeleton) the majority are sure the "plates make a network."

Teacher. "Therefore we will say that the back of the starfish is made of an irregular network of plates."

LESSON IV.

STARFISH (*continued*)

Teacher. "You have observed the upper side of the starfish, now turn your specimens over. What do you see in the middle of the lower side?" *Ans.* "A hole."

Teacher. "This hole is the mouth. What do you see running from the mouth into each of the five arms?" *Ans.* "A crack." "A gutter." "A sort of little road, with a wall; one at each side." "A groove." "A canal."

Teacher. "What do you see in the grooves?" *Ans.* "Dried-up things." "They look like glue."

Teacher. "What do you see here?" (The teacher passes the alcoholic specimen of an arm, or, better still, the living starfish.) *Ans.* "Round things, with squarish ends." "They look like little white tubes." "The tubes run in like saucers at the end."

Teacher. "Does any one know what these tubes are used for?" *Ans.* "They are feelers." "The starfish walks with them."

Teacher. "If it walks with them, what shall we call them?" *Ans.* "Legs." "Feet."

Teacher. "As they are shaped like tubes, and used in walking, they are called tube-feet." A number of the children know how tightly the starfish clings to rocks by its tube-feet. The teacher illustrates this subject by means of the leather sucker used in the lesson on the anemone.

Teacher. "Scrape out a few of the tube-feet, children, and what do you see?" *Ans.* "Holes." "Lots of little bones."

Teacher. "What did we call the bones of the back?" *Ans.* "Plates."

Teacher. "How are these plates placed together?" *Ans.* "They don't make a network." "They go in rows."

Teacher. "What kind of paper is this?" The girls quickly answer, "Perforated paper."

Teacher. "These plates which are in rows are called perforated plates. Do the holes pass through the plates as they do through the paper?" *Ans.* "The plates go out of their way to make the holes." "The holes are between the plates."

Teacher. "How many rows of holes are there?" *Ans.* "Two rows." "There is one row, and it goes this way and then that, like a fence."

If the children are under ten years of age the teacher does not pursue the subject farther, excepting to tell them that the starfish has five eyes, one at the end of each arm. When they are from ten to fourteen years of age she asks them to examine the cross-section of an arm. (If these sections have been soaked in caustic potash before the lesson is given, the plates fall apart easily. Sometimes weather-worn specimens are found on the beach which are equally good.)

Teacher. "Separate the plates, children; look at them closely, and tell me how many rows of perforated plates you find." There is usually a difference of opinion on this point, the number of rows ranging from two to six. If sufficient time is given, however, many of the class will decide that there are two rows in one arm, or ten in five arms.

Teacher. "What do you see at the end of the perforated plates?" *Ans.* "Nothing." "Sort of a knob." "Each perforated plate is round at the end."

Teacher. "See if you can separate this 'knob' from the perforated plate." *Ans.* "Oh, yes! The little round pieces tumble off."

Teacher. "We will call these round pieces imperforated plates. Do these make a network, or are they in rows?" *Ans.* "There is a row on each side of the perforated plates."

Teacher. "Therefore we have on the lower side of the starfish, how many rows of plates?" *Ans.* "Twenty rows."

Teacher. "Good. Now what do you see fastened to the imperforated plates?" *Ans.* "Teeth."

Teacher. "Then how many rows in five arms?" *Ans.* "Ten rows."

Teacher. "I want a better word." *Ans.* "Spikes." "Spines." The children compare these spines with those on the back, and the teacher tells them how these spines are movable.

Teacher. "What do you see at the tip end of the arms of the living starfish?" *Ans.* "A black spot." "I don't see anything." "It's red."

Teacher. "Should you think this red spot or eye was at the end of the rows of perforated or imperforated plates?" *Ans.* "It must be at the end of the rows of perforated plates." The children repeat in concert a summary of the two lessons, afterward they draw the starfish from above. The next lesson is a written description of the starfish.

LESSON V.

SEA-URCHIN

The teacher asks the following questions, varied somewhat, of course, by the answers of the children: —

"Is the sea-urchin a land or water animal? A salt or fresh water animal? Where have you seen living sea-urchins? What is the shape of the urchin? Place your specimens on the flat side, point to the upper side, to the lower side. What do you see on the urchin? Describe the 'spines.' Pull off one spine. What do you see at the lower end? Describe the place where the spine was attached. The spine is fastened by a 'ball and cup' joint. Where have we such a joint? Can we move our arm in one or more than one direction? Can the sea-urchin move its spines in one or more than one direction? What do you see in the middle of the lower side?"

The children describe the teeth, and the specimen of "Aristotle's lantern" is examined by them. By means of the stiff brush the teacher removes the spines, exposing the shell of the urchin. "What is the shape of the shell? What do you see on the out-

side? What was fastened to these 'half balls'? Are all the balls of the same size?"

The children look at the inside of the sections of the shell. "Is the shell made of one or of many pieces? What name shall we give these pieces? Are all the plates of the same size?"

The children examine the broken fragments and describe the plates. "By what name shall we call the 'plates with holes'? the 'plates without holes'? Are these 'perforated' and 'imperforated' plates placed together irregularly or regularly? We will say that these 'rows of plates' run from the lower side to the upper. Now, how many rows of plates are there? If there are twenty rows of plates in all, how many rows of perforated plates? of imperforated plates? What do you find on each side of the two rows of perforated plates? We will say, therefore, that there are five divisions, each consisting of two rows of perforated plates, with one row of imperforated plates on either side. Now, hold your shells to the light; what do you see opposite the mouth? This 'skin, with little things in it,' we will call a disk. Are the 'little things' or plates placed together regularly or irregularly? What do you see around the disk? Are these 'five holes' at the end of the rows of perforated or imperforated plates? What do you think one of those egg openings passes through? Now look again and see if you cannot find more than five holes? Are the 'fine tiny holes' at the ends of perforated or imperforated plates?"

The children repeat in concert a summary of their observations on the sea-urchin.

When the starfish and the sea-urchin are familiar, the two animals are compared. If the children are under twelve years of age they give simply the resemblances and differences that they observe.

1. "Between what rows of plates must you cut to get the five arms of the starfish?"

2. "What must you do to the imperforated plates?"

3. "What becomes of the eye-spots?"

4. "What has the starfish corresponding to the disk of the sea-urchin?"

5. "What must you give the starfish to make the skeleton complete?"

1. "To get the five arms of the starfish, cut between the rows of imperforated plates, and fold it out flat: this will give a row of imperforated plates on each side, with the perforated plates in the middle."

2. "The imperforated plates must be cut narrower. Bend them in so that you may have two rows of perforated plates, bordered on each side by a row of imperforated plates."

3. "The eye-spots being at the ends of the perforated plates in both the starfish and sea-urchin, when the sea-urchin is straightened out, they come at the ends of the arms, as in the starfish."

4. "The back of the starfish is the corresponding thing to the disk of the sea-urchin."

5. "Give it a top." "An upper side." "Its back."

In this way the beautiful and wonderful resemblances existing between the two animals so diverse as a sea-star and a sea chestnut-burr are graphically illustrated.

ORAL LESSON ON BIRDS.

Teacher. — Do you know that during this month a great multitude will come up here from the South, to spend the spring and summer? We shall soon see large and attractive parties of travellers arriving and settling themselves in their summer homes.

Scholars. — Who are they, and what are they coming for?

Teacher. — You must try to guess; they do not come by railroad or steamboat, although they travel as fast. They are coming now in such troops that there will soon be a million of them in Massachusetts.

Louie. — A million! What shall we do? There will not be room enough for them, nor enough to eat.

Teacher. — Oh, there are a good many of the houses they had last summer waiting for them, and they will go right to work and build all they need besides. As for their food, it has been kept safe all winter for them in little sealed cans which they know how to open, hidden in the places where they resort. I saw a crowd of them yesterday,

dressed in brown and dull red, opening some of the cans and eating the preserved fruits, and they had ices and frosting with their dessert, laid out on elegantly spread tables, supported and festooned by evergreens, spruce-boughs, and fir-boughs, and they had drops of balsam and spicy gums for their confections.

Bertha. — Why, Mrs. ——! what are you talking about?

Teacher. — I'm talking about the delightful company about to visit us from the South. They know more about some things in Nature here than we do, and they are all more or less musical, and will give us quite a concert every morning and night, and more or less through many days of the spring and summer.

Carrie. — I think I know. May I tell?

Teacher. — Not quite yet; but you may talk about them, without telling. Do you know how their houses are built?

Carrie. — Some of them are made of mud and sticks and straw and hair.

Teacher. — Do you know what they like best to eat?

Carrie. — Worms. (*Laughter.*)

Several. — I know. It is the birds.

Prescott. — I saw a little bird standing on the top of the snow, the other day. He took hold of a little stalk that peeped out of the snow, and shook it till lots of seeds fell down on the snow, and he ate them. Were they the food in the sealed cans?

Teacher. — Yes; the cans were hung up on that little stalk till he should come to get them. That little bird, and his relatives, had stayed here all winter, I think. How did he look?

Prescott. — He was black and white, with a big head for such a small bird; and he almost turned somersaults upon the fir-tree, and hung with his head down.

Teacher. — Was his head black, or white?

Prescott. — His head was black, and his breast was almost white.

Teacher. — We might call him Black-cap. Did he seem to be alone?

Prescott. — Oh, yes! call him Black-cap. There was a whole flock of them in the bushes, in the yard where those pink berries are.

Teacher. — Who knows his name?

Edith. — Was it the Chick-a-dee-dee?

Teacher. — The Chick-a-dee. That name is for his song; his other name is "Black-capped Titmouse." "Titmouse" is his family name. Have you all heard him sing?

Several. — Yes, indeed, we all know Chick-a-dee-dee.

Teacher. — He stays here all winter long, and we like him; why, Carrie?

Carrie. — Because he is so funny and nimble.

Lulu. — And so gay and not afraid.

Prescott. — I think, because he hops about the yard and gets the crumbs we throw him, and perks his head on every side and winks his eye at us.

Bertha. — Don't you think it is more because his song is so cheery, and he stays all winter?

Teacher. — You are all right. Hear about his nest and his eggs. He finds a snug hole in a post or tree, perhaps in a birch-tree, and lines it with soft feathers, or moss, or wool; then the last part of May is chosen as the best time to lay the eggs, — six little spotted eggs. Many of them go away farther north in the summer, and those who stay here are more shy, and keep more at home in the trees, where they pick out little bugs and insects' eggs from under the bark of the tree, as the Wood-

peckers do; then in the fall they are as lively and merry and social as ever.

Mabel. — I guess they are modest about their plain clothes when all the other birds are here.

Teacher. — Now, here are two eggs of the Chick-a-dee, and a picture of him, which Louie may draw on the board. Tell me his other name.

All. — Black-capped Titmouse.

Teacher. — But these birds were not of the hosts I spoke about, flying from the South, coming now, and all through March. I mean a larger bird.

Helen. — Robins. They are the ones that eat worms, and make mud and straw nests.

Teacher. — You are right. Where do they make their nests, Helen?

Helen. — Up in the apple-trees, in a corner by two or three branches. They plaster mud all in the place, and poke sticks around in it for a foundation. I have got one at home.

Teacher. — Here is one. It had to be pulled off of the boughs. See how strong it is, and rough outside; but is it rough inside, Ethel?

Ethel. — Oh, no; it is all lined with soft hairs and feathers, for the eggs to rest on.

Teacher. — What is the color of the Robin?

Hattie. — I believe it is gray and brown on the top, and deep red underneath.

Teacher. — I want you to watch carefully, and be ready to describe exactly the color and form of the Robin. You will be sure to see some of them within a week. Notice the color of his head, his bill, and legs, as well as his back, tail, and breast. See whether his tail is forked, and whether he jerks it or not. Watch whether he runs or hops, and what he eats. Hattie, you may draw and paint a picture of him for us to see; and who can bring his eggs?

Helen. — I can; they are lovely in color.

Teacher. — Yes, so lovely and so peculiar that we can only call it Robin's-egg blue. How many eggs are usually in one nest, and at what time of year?

Helen. — Four or five, in April. We only take one or two eggs out of a nest, and we don't take the nest till fall. Oliver and I got them.

Carrie. — I wish you could see them, Mrs. H., on our lawn, tugging at the worms, switching them out of the grass after a shower, and then biting them in short pieces, and flying off with a tassel

of worms hanging from their bills. They hop, and look around, and hop again; then they run so fast you can't see their legs go, and then they make a dive for a worm, and jerk him out by degrees; it is so funny!

Helen. — I saw them, last year, feeding the little birds, in a nest up in the big spruce-tree, right out of my chamber window. The young ones peeped and peeped, and crowded up, and opened their mouths as wide as all out-doors, while their mother and father kept coming with worms to drop into their big mouths.

Teacher. — How much worm does one little robin eat in a day?

Lulu. — Oh, I'm sure I don't know.

Teacher. — A man tried it once; he took a young robin out of the nest and fed it all day, and it ate fourteen feet of good, fat worm, — as much as if you should eat forty chickens, at least. They are greedy little creatures. Think what a number of worms are made only to feed the young robins every year. Are the robins of any use to the farmers?

Mabel. — I don't know. I should think they did harm, for they bite the cherries and strawberries,

and spoil nearly all of ours; and in the fall they bite the ripe apples and pears.

Teacher. — True; but, for all that, they benefit the farmer much more than they injure him. They eat up myriads of destructive worms and caterpillars and bugs which would spoil much vegetation and fruit. Do they rise early, or late, in the morning?

Bertha. — Oh, very early. I think they must get up before daylight, for they begin to sing just when a little faint streak of dawn comes through the window.

Teacher. — They are up by half-past three. Who can describe their song?

Mabel. — I know just how it goes. It is a little sad at night, but very musical, I think.

Teacher. — I am glad you have noticed it. Has any one heard their call to their mates, or their chirp to the young ones?

Maggie. — Yes, indeed; when they try to get the young ones to fly, they chirp all the time.

Ethel. — In the elm-trees, on our street, you hear them all day long, in June, and it sounds like a jolly chatter.

Teacher. — Their family name is Thrush. They

are coming toward us now, flying quite high, in merry companies, from the South. Soon the Bluebirds will start, and fly still higher, singing loudly and clearly on the wing, — the prelude of the spring to the snow-bound North. Watch for him, and tell me of his size, his color, and his habits, when you see him.

Bertha. — I saw a whole flock of them alight on the telegraph-wire and fences and trees around, as I was driving yesterday on the Acushnet road. They did look lovely; so blue, and such a pretty blue!

Teacher. — They want some nice holes, or bird-houses, or boxes, to live in. I hope they will find them and get sheltered soon, for we shall have some bitter cold days yet. Is the Bluebird's egg blue?

Helen. — Yes, light blue, sometimes white. I will bring one to-morrow.

Teacher. — Now, for a while, the Bluebird must eat berries; but later, bugs and beetles. It springs from the twig or perch, and snaps up the flying insect in the air, or the beetle and grasshopper from the grass. Has it any color but blue about it?

Lulu. — It has a kind of red breast, and partly white underneath.

Teacher. — It comes in March, sometimes in February, and builds its nest in April. It lays its first brood of eggs in May, but it often has two or three broods in the course of the summer, and they eat up myriads of insects. They go away again in October. Their song is sweet, but a little sad. Now they come flying on their long journey through the windy sky, singing as they come. How do you suppose they know the way?

Hattie. — That's what I always wonder.

Teacher. — So everybody wonders. I read a long article in a British magazine, the other day, upon the migrations of birds, but it did not solve the riddle, to my mind. Many people think the birds have a way of knowing things, so different from any way we know of seeing or hearing that we cannot understand it, — another sense which guides them; others think they learn the road by their keen sight and hearing, and that they have a regular track, which each generation of birds teaches to the next, and on which they have signs or guide-posts for following. Great flocks of birds that go from Africa to Europe, every year, cross

the Mediterranean at the same places, by just the same routes; one across the Straits of Gibraltar, and two others farther east. But we can't understand the birds as they understand each other. God takes care of them, and shows them in some way what path to take. Now, Carrie and Maggie, repeat together the last verse of Bryant's poem, which you recited in concert yesterday; and all be sure, before our next lesson, to observe the birds as they arrive.

Carrie and Maggie. —

"He who, from zone to zone,
Guides through the boundless sky thy certain flight,
In the long way that I must tread alone
Will lead my steps aright."

NOTE. — The preceding lesson is taken from "Practical Pedagogy; or, The Science of Teaching." Illustrated. By Louisa Parsons Hopkins. LEE AND SHEPARD, *Publishers, Boston.*

PART THIRD

PHYSICAL PHENOMENA OF NATURE— THE HUMAN BODY

PHYSICAL PHENOMENA OF NATURE

(*Sky, clouds, rain, snow, air, wind, dew, frost, brooks, hills, seasons, sun, moon, stars*)

THESE lessons are most valuable when incidental and suggested by present conditions. When the wind is blowing freshly, take it for a subject of observation and instruction; when the snow or the rain is falling, attend to that, and draw from the pupils the facts and inferences they are capable of apprehending. When the clouds are gathering, or when they rest in the blue sky, when the lightning and thunder arrest the attention, when the sun shines into the room, or when the shadows lengthen and it becomes too dark to study from books, then lead the observation and thought of the children to the natural phenomena before them, and let them talk about them under such direction as shall encourage their observation, excite their reasoning powers, and arouse their sentiments of love and reverence. There are so many sources of information for teachers in these departments that it seems unnecessary to enumerate them (see any good physical geography). In regard to the *sun*, the children can observe where it shines at morning, noon, and late afternoon; where the sunshine falls on the schoolroom floor at nine A.M., at twelve M., and at four P.M. at different seasons, so as to get some plan of its course through the year, according to the latitude. They can look at it through

smoked glass to observe its form; they can use a lens to get some idea of its burning power when focussed; they can observe its action on plant and animal life, to stimulate growth, or on jelly or other liquids to clarify them; they can discover by observation that sunlight can only be seen when reflected from some surface, and that even the air would be dark if it were not illuminated by reflection; they can observe it as a revealer of color, and be taught something of its importance to all life; perhaps they can be led to understand how it can be stored up as heat, to be developed afterward by combustion, as in wood used for fuel, or in coal, which has been called "consolidated sunlight." It is easy to find many good verses to accompany lessons. The *clouds*, like all the remaining subjects, can be studied by observation, either as to their form and motions, their changes and time of appearance, their origin, their use, and their beauty. Exercise the imagination by story-telling; commit pretty verses to memory on these subjects; make experiments of the evaporation of water, the production of steam, the effect of warm and cold air or moisture, the collection of drops of water on the outside of a cold surface in a warm room, the steam or frost on the window, or on the glass of ice-water. Call attention to the dew and frost upon plants and the ground, and to the delicate pearly webs on the grass early in the morning after a cool night; to the fog coming in from the sea after a hot day, or the gathering of a thunder shower, etc. All the subjects belonging to moisture, and the effect of heat and cold upon liquids, should be clearly connected in observation;

thus the clouds, rain, ice, snow, dew, frost, steam, evaporation, etc., are parts of one subject. Language lessons can be made very interesting as a sequel to observation lessons in this connection. In studying snow and frost, try to show their crystal forms and shapes of symmetry and beauty. The spherical form of a drop of water or of a bubble may be noticed and partially explained by the children. Some practical lessons on familiar machinery will interest most children; the pump, the windmill, the sail, the steam-locomotive, are not entirely beyond the study of children.

For instruction in physical laws, the plays of the children serve as well as anything for subjects. They will also give as much and as valuable physical exercise as any prescribed course of movements. The exercise of the body in playing ball, leap-frog, and other games; in swinging, skating, swimming, jumping rope, and so forth, — is of the best sort; and the various out-of-door occupations of children illustrate most of the physical phenomena and laws which children can understand. If the recess in the school yard were devoted to the playing of these ordinary games of childhood under the direction and with the participation of the teachers, the best of physical exercise would be provided, good will and harmony would be cultivated, and a great amount of mischief be prevented.

The games of graces, ring-quoits, battledoor and shuttlecock, are excellent for indoor exercise. The game of lawn tennis is excellent for outdoor exercise; croquet is too quiet; football for boys gives abundant and healthy exercise; running, rope-jumping, and hoop-

driving, are good if not kept up too violently and long. Skating and coasting are most thorough and healthful gymnastics in winter. There should be the required apparatus for healthful games in every yard: the swing, the tilt, bats and balls, ladders and posts, shovels, wheelbarrows, etc. The games might be systematically arranged for different classes, and for every recess. A lesson on the game might be given in the schoolroom directly after recess, and thus fresh observation and a lively interest in the physical laws involved be secured.

A number of illustrative lessons as suggestions of method are here given.

LESSON I.

THE SWING

(*For study of physics and for physical exercise*)

Mary sits in the swing; give her a gentle push. Why does she go forward? (The force of the push sends her.) Why does she come swinging back? (She went as far as the force could send her.) Why did she not stay up there? (Something drew the swing down again.) What drew the swing down again? (The earth.) Why does Mary not stop when she is nearest the earth? (The force which drew her back still carries her on till it is all used.) So it is, backward and forward, backward and forward, swinging like the pendulum of a clock, *oscillating* we call it; the force which carries the weight acts until overcome by gravitation, or the drawing of the earth, which is yet pre-

vented from bringing the weight to rest by the propelling force of its motion again.

Any suspended weight, once started from the perpendicular, will swing or oscillate until the friction at the point of suspension stops it. Mary overcomes this friction by pushing with her foot against the ground occasionally. Why does she lean backward when the swing goes forward? (To throw her weight as far back as she can, that it may act as a propelling force.) Why does she lean forward as the swing goes back? (For the same reason as for the reverse action.) Which will swing the faster, — the swing with a long rope, or that with a short rope? (That with a short rope.) Then, if you wish the clock to go faster, do you shorten or lengthen its pendulum string? (Shorten it.)

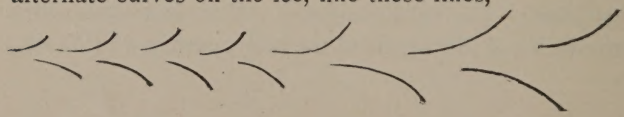
Mary and John may stand on the seat of the swing, hold the ropes by both hands; now start the swing, Mary, by leaning your body backward, and pushing with your feet forward; the swing goes forward; now, John, do the same to produce a reverse direction of the swing. Mary and John take turns in this movement, and the swing goes finely back and forth, higher and higher, but not too high, for fear of falling. What good exercise this is for their bodies! it strengthens the arms and legs, expands the chest, and makes them breathe fuller and freer, and makes their blood circulate better; it makes them feel quite refreshed. It is excellent gymnastic exercise. Where do you feel tired, Mary? (In the calves of my legs.) Where do you feel it, John? (In my shoulders.) You feel also a little tired around the middle of the body, perhaps? (We do.)

Rest yourselves by lying on the warm hay or grass, or by rolling gently, for all parts of your body have been exercised.

LESSON II.

THE SKATER

See Willie standing on his skates; the ice is smooth and dry; he can hardly keep his balance; he is learning to steady himself; he throws out one arm, now the other arm; why? he finds himself leaning too far on one side to keep up, so he throws out the opposite arm to restore the equilibrium, just as the girl carrying a pail of water in her right hand, holds out her left arm. Willie soon learns to move along on the ice, and steady himself, then to slide, first on one skate, and then on the other, without falling; how does he steady himself while sliding? by leaning over toward the side on which he slides; I should have thought that would make him fall; but his slide is a curve; when you run in a circle, do you hold yourself up straight? no, you bend inward; that is what Willie is doing because the outward curve of his slide is toward his upright position, and he keeps his balance by bending toward the inside of that curve. Now he starts on the other skate: which way does he bend now? in the opposite direction; this is the way he saves himself from falling, by bending toward the inside of the curve of his skate which is the outside of his general path; he propels himself by alternate curves on the ice, like these lines,



and his body sways to one side or the other after he has thrown it first forward a little to give his movement a forward impulse. What great curves that big fellow makes. His body is leaning easily backward and outward; he is a good skater; all his muscles are in graceful action; his body is perfectly balanced, and his whole frame in a healthy glow through this complete course of gymnastic exercise in the clear, cold atmosphere. He feels strong, courageous, and happy.

The human body in healthful activity is a form of grace and symmetry, it is much the most beautiful animal form on the earth, if we do not cramp or maim it. The deer and the horse are very handsome in shape, but the child and the man and the woman are intended to be more perfect in form and action, and of a higher beauty.

LESSON III.

THE SEE-SAW OR TILT

Tommy sits on one end of a plank resting on a stone, and Sammy on the other; they are both of a size, at the same distance from the centre, and their toes just touch the ground when the plank is even and not tilted; now Tommy bears his end down a little, and what becomes of Sammy? (He goes up on *his* end.) Now Sam bears down, and what becomes of Tom? (He goes up; what fun!) They go up and down, see-saw; one is just as heavy as the other, and each gives a little spring to send his end (up); and bears down a little to push it (down); when one is up, the other is (down); and when one is down, the other is (up).

Now Tom moves along on his end toward the middle, can he push down as easily as before? (No.) Something helped him before; what was it? (The longer plank between him and the middle.) Sam gives a spring, but he doesn't go up easily; Tom stays up in the air; move back, Tom, toward your end; — now can he bear down? (Yes.) And Sam (goes up). If Tom is farther from the middle, he can bear down (more easily). If nearer (not so easily).

Now let a bigger and heavier boy than Tom get on in Tom's place. Can Sam bear down his end as easily? (No; the heavier the boy, the harder it is to lift him.) And the greater the distance from the middle (the harder it is to lift him). The plank is the lever (or lifter), the boy who is up is the weight, and the boy who is down is the force or power that lifts him; the point where the plank rests is the *fulcrum*, or support. The greater the weight and the distance from the fulcrum, the (greater) the force or power needed to lift it. The lighter the weight and the nearer the distance, the (less) the power. If the see-saw plank rests on a fulcrum nearer one end than the other, on which end must the heavier boy sit? (On the short end.) Which boy, the heavier or the lighter, must be nearer the middle? (The heavier.)

LESSON IV.

THE WHEELBARROW RIDE

Joe takes his little sister out in the wheelbarrow; he lifts up the handles, and trundles her along. She is the weight, and he is the force or power that lifts it;

where is the fulcrum or support? (At the place where the wheel touches the ground.) She must sit well toward the wheel, or she will be too heavy. The nearer the weight is to the fulcrum, the (less) the power.

LESSON V.

CRACKING NUTS

What a nice feast we have with these English walnuts, almonds, and filberts. Who knows how to use the nut-crackers? Sallie and Helen may each take one. Where is the force or power? (In the hands.) Where is the weight, or that which is to be broken? (The nut.) Where is the fulcrum or point of motion and support? (The joint of the nut-cracker.) The weight, then, is between (the power and the fulcrum). This is not like the see-saw, where the fulcrum was (between the weight and power), but like (the wheelbarrow). The see-saw is the first and the wheelbarrow the second kind of lever. There is another kind, the third.

LESSON VI.

THE TONGS (*Mending the Fire*)

O Harry, the wood has burned so that the stick has broken; will you take the tongs and pick up the ends which have fallen on the hearth? yes, Harry tries, but he does not handle the tongs properly; he holds them by the knob on the end, Mary may try; she does it properly and picks up the brands; how did she take

the tongs? where did she put her hands? (Below the joint.) Where is the weight or resistance which was to be overcome? (The brand.) And at what part of the tongs, or the lever? (The end.) Where was the fulcrum? (At the joint of the tongs.) Where the power or Mary's hands? (Between the fulcrum and the weight.) This is the third kind of lever. (Answer all similar points of observation in regard to the crowbar, steelyard, scissors, oars, the arm and hand, and illustrate each kind of lever in as many familiar ways as may be.)

LESSON VII.

ROLLING HOOP

Strike the hoop with your knocker; what is its motion? (Rolling.) Now it rests on one point, then on the next, and so on until it has rested on (every point of its circumference). And touched the ground at (every point). What is it like in motion? (A wheel.) Yes, a wheel is a hoop fastened to what? (An axle.) The axle to (a pole between two wheels). And the pole to (a carriage). When the wheels turn they carry the axle and carriage forward. Try to think how it is like the motion of your body in walking and running. When you walk what do you do? (Lift up our feet and put them down.) When you lift up your foot what does your body do? (Go forward.) If you did not put your foot down presently, what would your body do? (Fall to the ground.) But you put it down and lift up the other, then your body goes still (forward), and moves like the

(hoop or wheel); so you go rolling along, changing your support, or touching the ground in a new point so as to carry your body (forward). Now run easily and regularly, and notice how your feet keep changing the place of support so as to carry your body forward like a wheel. When you jump do you change your position more easily or more violently? How does the horse, the bird, the snake, the frog, the rabbit, the fish, the crab, the starfish, carry the body forward? Analyze the motion and imitate it.

LESSON VIII.

JUMPING ROPE

Kate and Nat may swing the rope, one at each end; each scholar may have ten jumps. How can you swing the rope so evenly? (When you start it well, it almost goes itself.) When anything gets into motion it tries to keep on regularly in even time. While you jump over it, you can keep time, or count because it swings so regularly; don't keep it up so long as to make your heart beat hard. The swing goes back and forth when it is well started; what else can you think of that swings back and forth evenly? (The clock.) A part of the clock is the pendulum which hangs by a string. Any weight hung by a string and started in motion will try to keep up the motion in exact time; we say it *oscillates*. Will it stop at all? yes, after a while "the old cat dies," we say, when the swing stops. What stops it? (The earth trying to hold it down; and the air making it hard for it to go.)

LESSON IX.

FLYING KITE

Is the kite light or heavy? broad or narrow? now let Jimmy hold it up while Fanny runs with the string. Let go, Jimmy, as soon as it wants to go up; what holds it up? (The air.) Will it go up better in the wind? (If the wind is steady and not too violent.) Will it go better, or not, when Jimmy runs? (It will go better.) The air pushes it up as Jimmy pulls it against the air; up, high up it goes as he lets out the string. How the air pushes it now! hold the string hard, or it will blow away. Is the air strong? can it push hard? will a thing be more easily carried up by the air when it is light, or heavy? (Speak of ships whose sails are pushed by the wind, of balloons, of soap-bubbles, of feathers, etc.)

LESSON X.

MARBLES

Which way will your marble roll? why? put a marble on the floor and roll another against it; what happens? (The marble that I roll stops when it has hit the other marble, and the one which was hit rolls.) What made your marble roll? (The power of my hand.) You put that power from your hand into the marble, which carried it and gave it to the marble that was still. When you give something away, do you still have it? so the marble gives its force away to the other marble. Put

your marbles in a row touching each other, now roll another marble so as to hit the first one of the row; what happens? (The last marble of the row rolls, the others stand still.) The power you gave to the rolling marble was communicated to the first of the row, was given by that to (the second). By the second to (the third). By the third to (the fourth). And as there was no other to give it to, the fourth used it up in rolling. Each communicated its force to the next, till the last one spent it in rolling. (Elasticity may also be explained in this and the next lesson, as an element of projectile power.)

LESSON XI.

BALL-PLAYING

Throw the ball up high, does it go away to stay? (No, it comes back.) What makes it come back? What makes the apple fall to the ground when it breaks from the tree? what makes the drops of rain come down? why do they not fly away? what makes you come down to the ground when you jump up? (I am heavy, the ball is heavy.) What do you mean by heavy? What does the earth try to hold us to? (It tries to hold everything to itself.) So when the ball goes up with the force you gave it, why does it come back? (When it has used the force in going up, it comes back to the earth, which is always pulling everything toward it.) Now I stand opposite you and toss the ball, for you to catch; if I aim it directly at your hands will it reach them? (No, it will not reach high enough.) Then, I must aim higher than I wish, to reach and toss the

ball; why? what is pulling it down? (The earth.) Yes, it will mind partly the force I give it, and partly the earth; it will go between the path upon which I start it and the path toward the earth. How many forces are acting upon it? (Two.) And the action of those two forces results in its path toward your hand, so that you can catch it. We call that path the *resultant* of the two forces which act upon it. When two different forces act on a moving body, what course will it take? (It will take the course of the resultant of the forces.)

Now, throw the ball against the wall; what does it do? (It comes back to me.) The force with which you threw the ball went into (the ball). The ball gave it to (the wall). And the wall gave it to (the ball) which brought it back to you. It is like the communication or passage of force in the rolling of the marbles. Throw the ball forcibly to the ground; what happens? (It rebounds.) The force you gave the ball was communicated to (the ground), and from the ground back to (the ball) so as to toss it up to your hand again. The ground re-acts or acts back on the ball; — so does the wall. Where there is action of one body upon another body, there is always re-action of the second body, and the action and re-action have the same force. When you start a ball in motion by throwing it, would it fall if the earth did not attract it nor the air hinder it? (No.) Then we will say that a body once set in motion will move in a straight line and with a steady speed until some outward force prevents it. And when we think of the course the ball takes between the two forces acting upon it, we will say that the course of a moving

body will be the resultant of the forces acting upon it; when we think of the rebound of the ball from the wall or floor, we will say that action and re-action are equal and opposite. These three things which we have observed and stated are called the three *laws of motion*, because they are always true and always obeyed.

LESSON XII.[1]

I. — PRIMARY CLASS IN PHYSICS.

Teacher. — Prescott, yesterday I saw you drawing Dick up Union Street in your cart. Was it as easy for you as to draw him down the hill?

Prescott. — No, ma'am; but I had to hold back almost as hard going down.

Teddy. — The cart goes itself down the hill.

Teacher. — Oh, no; something is pulling it down which you didn't see. Let go of that book in your hand; what made it go down?

Willie. — It is heavy.

Teacher. — What does *heavy* mean?

Prescott. — Hard to hold up.

Teddy. — It pushes hard.

Teacher. — There is a power of the earth which pulls everything toward it. It is called gravitation. You may all write the word. It makes things seem heavy when they push hard toward

[1] The following lessons are taken from "How Shall my Child be Taught," published by LEE AND SHEPARD, Boston.

the earth, or have much weight. Did you ever try to lift something which you could not lift, which was too heavy for you?

Lottie. — I tried to lift Willie's boat, and it was too heavy.

Teacher. — The earth pulled it stronger than you could. The earth pulls all things all the time. Can you think of anything which will not drop when you let it go?

Madge. — A feather will fly away, and a seed and leaves sometimes.

Teacher. — There is something you do not see which holds them up, although the earth still pulls them down. Who knows what?

Maggie. — The wind blows the leaves, and the hot air will keep up any light thing over the register.

Teacher. — The air holds up everything, somewhat. A feather is so spread out, and there is so little of it, really, that the earth does not pull it down so strongly as the air holds it up, and the hot air pushes up still more than cold air. If you hold a piece of paper on the palm of your hand, your hand holds it up; if you take your hand away, it goes slowly to the ground, because the

air still partially supports it, and its substance is so spread out that it gives a large surface for the air to support, compared with the weight of it, or the force with which the earth pulls it down. Now a great part of the force which men use is used in resisting this force of the earth, or in lifting things which are heavy. The other day I saw a man lifting very heavy bales into a high window in a warehouse. How do you suppose he did it? by just pulling them up with a rope?

Teddy. — I guess he had a pulley.

Teacher. — So he did. Show me what a pulley is; draw a picture of one on the board.

Teddy. — He had a rope fastened to the bale, and it went up over a little wheel which was fastened to a beam high up, and the rope hung down the other side of the wheel for the man to pull.

Prescott. — When he pulls down, the bale goes up.

Teacher. — That is a contrivance to make it easier to pull. Such contrivances are called machines. Did you ever see a man try to lift a rock which was too heavy for him, by any other machine? Prescott, if you had been with Lottie

when she tried to lift that boat, what could you have done to help her?

Prescott. — I might have pried it up with a stick; or, if I could have got a crowbar like that the men had to get those stones for the cellar up on to the truck, I could have done it easily.

Teacher. — Yes, the crowbar; that is a machine; a very simple one; only an iron bar. It is like having a very long, strong arm, like a gorilla. Aren't you glad that God gave a man a mind to think of machines, and did not have to make him like an ape? What other machines has man invented to help lift? I will make this square to represent the heavy thing which is to be lifted. Here is a line for the string to lift it by. Now let us have it wind over this axle, which has a handle at the end for a man to turn. What does that look like a picture of?

Class. — A well, and drawing up the bucket.

Teacher. — Yes, it is a machine called a windlass. It is easier to put the strength of a man, or of a horse, or of steam, or any other power upon turning that handle, or what is the same thing, turning a wheel, than it is to set it at work merely lifting. Now, in the pulley, which is a string run-

ning over a wheel, you can easily set some other force than man's strength at work. I will make this picture of the bale of goods, and the rope which lifts it running over the wheel. Now, instead of having a man pull the rope down, suppose I want a horse to pull it ; what shall I do ?

Teddy. — Make another wheel, fastened to the floor of the loft, and let the rope go round that, so that a horse can be fastened to it and walk along, pulling it, and back when he lets it down.

Teacher. — Suppose I can't get the horse up into the loft very well ?

Prescott. — Why, let him be down on the ground, and have the other pulley down there, and it will be all the same, — just as they do at the coal yards to load the vessels with coal.

Teacher. — Tell me of all the machines you have seen, for the next lesson. Write the names of them on a paper, and be ready to explain when and how they worked when you saw them ; and if you ever have something to do which you think at first you cannot do, set your wits at work to think of a way to get some other power to help you. Invent a machine to do your work for you. That is the way for a Yankee boy or girl, and

for every one who wants to accomplish much in the world.

II.

Teacher. — Here is the ash-cart, children; there are three barrels full of ashes. They will be heavy for the man to lift.

Prescott. — I know how he will get them up. He will take the back-board out, and lean it up against the cart and roll the barrel up.

Teddy. — Then all the ashes will fall out.

Prescott. — Well, if they were flour-barrels, he could roll them up.

Teacher. — Suppose they were flour-barrels, why would he roll them up?

Willie. — It isn't so hard to lift them.

Teacher. — The board partly supports them; it is a machine; it makes it easier to overcome gravitation, and adds to the force of the man. That board, or anything which gives a slanting surface on which a weight is raised, is an *inclined plane.* The meaning of the name is clear. Did you ever see a man chop wood, and then put a wedge like this (>) in the split, and drive it in to complete the separation of the wood?

Madge. — Is that a machine?

Teacher. — What is each long side of it?

Ethel. — An inclined plane.

Teacher. — The wedge is a machine, then, — a double inclined plane. Will it split the wood across, as you might saw it?

Helen. — You have to drive it in with the grain.

Teacher. — Just as the axe goes in. Now what is the axe?

Frank. — That is a machine.

Teacher. — Is there any inclined plane about it?

Teddy. — It is just like a wedge.

Teacher. — That is true; it is a wedge with a handle for the man to use in applying the force of his muscle to drive the wedge in. What is the wedge used for besides splitting? You cannot tell. Did you ever see men raising a building or a ship?

Maggie. — I saw them launch a ship, and they hammered in under it to lift it. Were they driving wedges?

Teacher. — Yes; they drive great wedges in under the keel; if they drive a small one at first, then they can drive in a larger one afterwards, and so raise the ship quite off the ways to launch

it into the water. Sometimes to press things very tightly wedges are used, — to squeeze seeds together or fruit, to get the oil or juice. Wedges are used in many ways. I want to make a hole in this wood ; I cannot press a blunt end through it immediately, so I take a wedge which has an inclined plane all around it, — this pin, or a nail, or an awl, — and push it in ; the resistance of the wood is overcome gradually.

Gertrude. — I never knew that a pin is a machine.

Teacher. — What is a knife ? Are not all sharp, cutting instruments wedges ? Scissors are two wedges pivoted together. See, they work on both sides of what is cut, and meet in the middle. But what is it that keeps the wedge where it is driven ? It might slip back, by the pressure on the inclined plane.

Teddy. — It gets pinched in.

Teacher. — It is friction which holds it ; the roughness of the wedge and the substance which it rests in act upon each other to hold it still, until some stronger force of driving is used again. If you use force to put a thing in motion, when does it stop ?

Madge. — When anything stops it.

Teacher. — What stops a ball after it is thrown?

Teddy. — It falls down.

Teacher. — The earth stops it by gravitation, but it stops it gradually, because the force which started the ball yields gradually to the force of gravitation, and *something else.* If you should start a ball rolling on a plane, why does it stop? Will it stop sooner on a rough surface than on a smooth one?

All. — Oh, yes.

Maggie. — It is the rubbing on the surface it rolls on which stops it.

Teacher. — That is *friction.* There is less friction the smoother the surfaces, but there is some friction however smooth the surfaces; and all the friction is not in those surfaces, but a part of it in the air. That is what stops a thing moving through the air. Even if it were not for gravitation, the friction of passing through the air would stop it. So you see friction stops a moving thing and holds it in its place with much power. If you rub things together very quickly, the friction makes heat and even fire. This was the way in which people used to make a blaze.

If a body moves very swiftly through the air, it will at last take fire.

Teddy. — Rockets will.

Teacher. — Rockets are set on fire before they begin to move; but meteors or shooting-stars are great bodies of metal which are sent spinning through the earth's atmosphere by the great force of gravitation, and they move so far and so swiftly that they take fire by friction with the air, and burn and melt as they whizz by, until they fall to the earth, and cool to look like a great mass of iron-ore. We see them flashing along the sky some nights, and I have even heard them whizz. Friction has to be taken into account, in considering the effect of any application of force. It stops and it holds. It makes heat and flame and electricity. It is greater in proportion to the roughness of the substances it affects. I was in a train of cars once when they had to stop because the wheels had grown so hot.

Prescott. — They ought to have oiled them more, and then it would not have happened.

Teacher. — The oil would have made the surfaces smoother, so that the friction would have been much less. Do you know how very much

oil is used to make surfaces smooth and lessen friction?

Carrie. — Machinery has to be oiled very often, to go smoothly. I saw a man climbing all over the great engine in the steamer, with an oil-can.

Teacher. — Did you ever rub sealing-wax on woollen until it would attract other things toward it, such as hair or feathers?

Agnes. — I saw Louis doing it one day, and the sealing-wax was hot.

Teacher. — That is because the friction brought out heat and electricity. The heat and electricity must have been both in the wax; the friction brought it out. Some day we will say more about this; but now we are thinking about friction only as a means to stop and hold; sometimes of use, and sometimes an obstacle to be overcome. An obstacle is not worth minding if we can only bring force enough to overcome it. We can soon learn to turn it to good account. *Friction* we may set aside for the present, and go back to our machines. You may all cut an inclined plane from this paper, and wind it around your slate pencil from the wide edge. What does this line twining around the pencil remind you of?

Willie. — It looks like a screw.

Teacher. — Here is a real screw. Twist it into this hole in the wood. The inclined plane is turned all around in the hole, gradually working its way wholly within. If the winding edge of the plane is sharp, it cuts its way in like a revolving wedge, or it pushes the resisting wood up its spiral inclined plane, with a gradual force, easier to apply than the sudden blow upon a nail, which is only a straight wedge. Remember, then, the *inclined plane*, the *wedge*, and the *screw* are various forms of the same thing, and used in every variety of machine to assist man in the application of force to do his work. This *force* or *power* may be man's muscle or the muscular power of some animal, the steam of an engine, water, air, electricity, or any of the forces of the earth which man has learned to use. The machines help the natural forces to do more work and with greater ease than would be possible without them.

III.

Teacher. — Let us see what we know of the forces of water, and how they may be used. If

I put water in this cup, and now punch a hole in the bottom, what happens?

Holly. — The water runs out.

Teacher. — Now I will punch a hole in the side.

Prescott. — The water runs out there, too.

Teacher. — Now this teapot is full of water, but I am pouring in more?

Lottie. — It is running out of the spout and over the top.

Teacher. — And the spout is as high as the top, so the water is pushing up as high as the top. Which way does water push, then?

Lily. — It pushes every way.

Teacher. — If I put this book in the empty pitcher, does it change the shape of the book?

Madge. — No.

Teacher. — Here is some water in this cup. What shape is the water?

Teddy. — It is the shape of the cup.

Teacher. — Suppose it were in a square box what shape would it be?

Prescott. — Water will be the shape of what it is in, of course.

Teacher. — Now, if I put the water that is in the cup into the pitcher, will it change its shape?

All. — It will.

Teacher. — The water spreads itself every way, then, and changes its shape, and a solid thing does not.

Madge. — Why does it?

Teacher. — I cannot explain it more than to say that the particles of a solid thing hold together more strongly than they push apart, but the particles of water push apart as easily as they hold together. And how is it with air? Does that push apart more easily or hold more firmly together than water?

Teddy. — It pushes apart more easily.

Teacher. — Yes; it fills everything, no matter what its shape or how large. Its particles separate as far as they can from each other. Now, as to water, you all have faucets in your houses; where does the water that runs from them start?

Prescott. — I know; from the Reservoir; and it is pumped there from a pond further off. It runs through pipes in the streets and houses.

Teacher. — Have you ever known whether the Reservoir is built up high or dug down deep?

Lily. — My uncle planned it, and it is a high building.

Teacher. — It has to be high. I will show you with this bent glass tube. I dip this end in the water, and now look and tell me how high it comes up in the other side of the tube.

Holly. — Nearly as high as the top of the cup.

Teacher. — Water will run as high and no higher than it was where it started. Now, some of the houses in town are up on a hill, and high; so in order that the water shall run into their pipes, it must start as high as they are, and the Reservoir was built as high as that.

Prescott. — At Teddy's they have a tank up in the attic; I thought that was so that the water would run down the pipes.

Teacher. — That was put there before the water from the Acushnet Reservoir was brought in pipes, and it was arranged to be filled by the spout from the roof, I suppose. Do you use it now, Teddy?

Teddy. — No; only to sail boats in it, and wade in it. Prescott got up to his knees in it, the other day.

Teacher. — Yes, I remember it very well. He had to pull his boat along by a string, as he couldn't use the force of the water to push it. How do you get your boat along in the river?

Madge. — We row it.

Teacher. — What force of the water do you use?

Holly. — The oar pushes against the water, and the water pushes back on the oar.

Teacher. — Which has to push the harder?

Lily. — The water.

Prescott. — No; the oar.

Madge. — Why, one has to push just as hard as the other.

Teacher. — Right. And that brings the boat up to the oar when the rower leans back. Now, all make believe row, and think how it is. See: you depend on the pushing or resisting force of the water against the oar and the force of the man's arm to oppose it. Once they had boats with three tiers of oars, — ships with a large number of rowers.

Holly. — I know it. That was like the Grecian ships, and the ships of Xerxes, the triremes.

Teacher. — How does the "Martha's Vineyard" go?

Lily. — It goes by steam.

Teacher. — The steam alone wouldn't make it go.

Prescott. — The side-wheels make it go.

Madge. — The steam turns the wheels.

Teacher. — Who has observed the wheels?

Ethel. — They are like a good many oars moving, when the wheel turns round.

Teacher. — Yes, you must notice that when you go off in her, this summer. How is it with the propeller? Who knows? What does the steam do to make it go?

Maggie. — It turns a screw of four great curved scullers, at the end of the boat, in the water, and the Nonquitt boat goes in the same way. My father showed me about it, as we came up to town, one day. How does a ship go? What moves it, Mrs. Hopkins?

Teacher. — You know what the sails are for. The water does not make it go, it only retards it; the wind must push harder on its sails than the water against its hull, or it will stand still, unless it gets into a current of moving water, when it will move with the tide. There are hundreds of ways in which the pushing force of water is used; wheels of factories are turned, and all sorts of contrivances and inventions are used to make the most of it, to get all the advantages possible from

it. But here is something else. This towel has one end only in the water; this sponge touches the wet table only on its under side; does all the rest of it remain dry?

Class. — Oh, no; the sponge is wet all over now, and the towel is growing wet.

Teacher. — The other morning I found the floor near my sink was quite wet, and then I discovered the towel thrown over with one end in the basin where there was some water, and the other end dripping over the edge of the sink. How was that?

Teddy. — The towel and the sponge suck up the water.

Teacher. — The water climbs by little threads, or through little holes or tubes; it creeps up the sides, and fills the pores of the sponge, the web of the cloth, the cells of the plants and trees, in which the sap rises and oozes through the thin membranes. It climbs up a chain, too, in the same way; sometimes very fast.

Madge. — I know it does in our chain-pump. I draw the chain up, and soon the water comes so fast that it comes out of the spout, and I hold my face over and drink.

Teacher. — Now, you can often get this climbing-

force of the water, its disposition to follow a fine thread or tube, its *capillary attraction* as it is called, to help do something important. Keep it in mind, — you may want to use it. If you were very thirsty, and saw a deep well but nothing to draw with, could you contrive some way to get a drink?

Lily. — I could. I'd tear my dress up and make a long string, and suck up some water out of it when one end was down in the well.

Teacher. — Before the next lesson, I want you to think of some other forces of water, and how they are used. Perhaps you can discover or invent something.

Holly. — Do you believe we can?

Teacher. — I have no doubt you can, if you watch and think. Most likely it will be something that has been discovered or invented by somebody else, but that is no matter. It is just as good for you to find it out yourself, as if no one else had done it.

IV.

Teacher. — If you wish to move your arm, Holly, how do you do it?

Holly — I make myself.

Maggie. — You told us in Physiology that the will is carried from the brain to the muscles by the nerves, which contract the muscles, so that the arm moves; it goes by a sort of telegraph, so quickly that we don't know any more than that when we want our arms to move, they move.

Teacher. — You have learned to control the force there is in your arm; you didn't know how, when you were a little baby, and had to learn by trying. I saw a child as large as you, Holly, that hadn't learned, because his mind was too foolish, and he couldn't manage his arms or legs at all; he lay on a cushion like a little baby, only because he had not the sense to learn to use the force of his own muscles. Can you control any other muscles besides your own, Prescott? If you have a load to draw which is too heavy for you to pull, what can you do?

Prescott. — I can get a horse to pull it.

Edith. — Or an ox.

Dolly. — Or my dog; he carries a basket, or draws my sled.

Teacher. — Of what advantage is it to make the

horse and the wheel do it? Could not a man use the saw and cut the wood with the force of his own muscle?

Dolly. — Yes; but the horse is stronger, and can do it a great deal faster with the wheel. I saw a horse going round and round in the street, the other day, and winding a rope about an axle so as to pull a house along.

Carrie. — I saw, down on the wharf, a horse going forward and back, to hoist a box of coal and lower the empty box.

Teacher. — Did you ever see a dog's muscle used to do work? Dolly uses her dog.

Gertrude. — When I was in New York with mamma, I used to see the dog-carts go round every morning to get rubbish.

Teacher. — Once people used to roast meat before the fire; they had to keep it turning all the time. It was tiresome for a boy or woman, so they trained dogs to be turnspits.

Maggie. — How funny! I have seen a bird trained to lift its food into the cage with a string, and a monkey to fire a gun.

Lily. — In the cold countries, the reindeer draws the sledge.

Sylvia. — In South America, the beautiful little llamas carry the loads down the mountains.

Holly. — In the hot countries, they use elephants to carry loads.

Prescott. — In the desert, camels.

Teacher. — Can man control all these animals, and make them do his work, without trouble?

Holly. — No'm; they have to be trained.

Prescott. — They have hard work to train them, too, and they have to tame them first.

Teacher. — Do you think man will ever have under his control all animals, — the wild animals, — so that they will do his work?

Maggie. — Perhaps so. Do you think so?

Teacher. — I think it possible in the future; for man is made as the head and king of all the forces of the earth, to control and subdue them. He has to learn to make the most of his own forces by training his body and mind, and then he can add to this power of his own the power of other animals which he tames and trains; because God made man to have dominion over all creatures of the earth, to do his bidding.

V.

Teacher. — Prescott, see how the gutters run to-day; the snow is thawing fast. Do you think of any work you can make that swift stream do?

Prescott. — I see it push a good deal of slush along itself; it is doing its own work.

Ethel. — Oh, Mrs. Hopkins, don't you remember all that you read to us out of the *Fairy Land of Science*, about the water and ice and snow? They do wonderful things that men cannot do.

Teacher. — That is true, but they will at the same time stop and do a little job for us. If Holly should put a little wheel out there, would the gutter stream turn it for him?

Holly. — I guess it would. I should stick the wheel up in lumps of snow so that it would just dip into the gutter, and the stream would turn it quick enough.

Teacher. — Suppose it didn't turn as fast as you wanted it to?

Prescott. — We could make a dam and a waterfall, and then it would go rushing.

Teacher. — A great deal of work is done in this way, by using the force of running or falling

water to turn wheels. I have seen an immense wheel turned by water falling over a great dam, built in the Merrimac River, and this wheel by belts turned a great many wheels and spindles in a large cotton factory. Ethel, do you remember the windmills on the road to Nonquitt.

Ethel. — Oh, yes; those great sails are turned by the wind and pump the water up to the top of the high frame, so that it will trickle down through all the branches laid upon the frames below and leave salt upon them. Mamma explained it to me one day.

Edith. — I can make a windmill myself.

Teacher. — So you can; but you must try and see if you can make it do any work. You want to use the force of the wind. What a tremendous force it has; and the force of the air as you push against it is very great to resist you. You must think how you can use its power to resist, as well as its power to move. Air and water hold great forces, which man must learn to control. He must first find out how they will act, and then how to use them. The force of the earth drawing all things to itself is another force we can use. Suppose two boys are throwing snowballs. One

boy stands on a level with the mark he aims at, but the other goes up on a high place and throws them down; which is the wiser boy?

Dolly. — The boy who went up high, for it is easier to throw down.

Teacher. — Yes, that boy got the earth to help him. It is the force of gravitation. A man by the name of Isaac Newton first watched an apple falling from a tree and thought about it until he understood that the earth draws all things toward itself. This explained a great many things, and led to other discoveries. The earth has many forces. We have only begun to find them out. They are waiting like restive horses in their stalls for man to bring out and use. Perhaps you can discover some of them. All is done by observing and thinking, watching, trying and contriving.

The brain of man is given to him by God to use that he may be the master of the earth, that he may make the air, the earth and the water, and even the sun, moon and stars, work for him.

No one, not even a child, is left to do things by himself; the air and water wait upon him all the time, and the great round earth, and even the sun, moon, and stars help him; all men who have lived, or who now live, and all spirits, may help him too.

THE HUMAN BODY

A CHILD should think as little about his body as possible. He should use it as unconsciously as is consistent with its development. If it is necessary to observe it at all, it is well to lead him first to observe *the hand.* No other animal has a hand which is used for creative work. The child may observe the fingers and their adaptation to their uses; he may learn that they are given him for helping himself and others; for building, for touching and feeling, for moulding, for drawing, and in all ways for the expression of his love and his thought, so that they can be communicated to others. They are not for walking or climbing like animals, except when the baby uses them to creep, but they are for doing things and holding tools which can help him to do more than animals can do.

Manual training of all kinds comes into the expression lessons connected with observation on the human body. Physical exercise for all parts of the body should accompany the study of the human body; — that study for the child should not be too analytical or involve dissection. Images of disease or deformity should never be presented to the child. What is naturally within the observation of childhood is a sufficient groundwork of physiology in primary schools. Observation of the senses and their development, the bodily

motions, and for children without proper home care, the bodily habits, personal cleanliness and attractiveness, the necessity of regularity in purely animal necessities such as eating, drinking, bathing, etc., should be carefully inculcated and insisted upon; but the child should be reminded that he is not merely an animal, but a human being, and that he has other and higher things to think about; that his body is the *tool* of his soul; that he must not be like an animal in thinking of his body when it is not necessary; he should be taught that it is unpleasant and impolite to perform any bodily function conspicuously or offensively, or when unnecessary. In all ways teach the child that principle of good manners which consists in refraining from attracting attention to the person by manner, or condition, or dress; and that it is degrading and unworthy of a human being to cultivate or exhibit the animal propensities.

Give the child ideas and practice in healthful diet, proper clothing and right habits; show him models of perfect hands, faces, and forms; let him study pictures of noble men and women, and models of human perfection of the body both in repose and action. Teach him how to hold and carry himself well, to keep his head steady and easy, to sit and stand erect, to move gracefully, to use his body well and not abuse it. Teach him that as the home of the soul, made for its wants and development, it should be clean, pure, healthy, and well cared for. Teach him the details of neatness as to the hair, the skin, the face, the eyes, ears and nose, the teeth and nails, and the whole

body; teach him the right methods of bathing and eating, how to behave at the table, how to make himself personally and unobtrusively pleasant as a companion. Teach him the complete use and control of his eyes and hands, as a member of society, and for the purposes of education, that he may know how to gain accurate knowledge, and how to express or to hold in reserve his thoughts and feelings, and act his part at home, in school, and everywhere, so as to make the most of himself for the sake of others, and to be what God made him to be in the world. Many a person has reformed his life through a better understanding of the human body.

All kinds of handcraft may be shown by pictures or other material, and various kinds imitated. Many songs can be sung in primary classes which involve motions and uses of the hands. Teach that the hand is the distinctive organ of the human being; compare it with the fore paws of animals, the wings of birds, the fins of fishes, the trunk of the elephant, the antennæ of insects.

"Little Susy's Six Servants" is a very good book to read with such lessons.

NOTE. — The following lessons on the human body are from "How Shall my Child be Taught," published by LEE AND SHEPARD, Boston.

CHAPTER XI.

PRIMARY CLASS IN PHYSIOLOGY.

I.

AFTER an exercise in calisthenics, the six youngest pupils remain standing.

Teacher. — What nice twisting bodies you have, just like india-rubber! Is that what you are made of?

All (laughing). — No; we're made of flesh.

Teacher. — How do you keep up straight, then?

Prescott. — We have bones.

Teacher. — Any bones like this (showing a fish-spine)?

Holly. — No; I guess not.

Teacher. — When you undress to-night, feel up and down your back, and tell what you feel. You may feel of each other now, gently. Madge, what do you feel on Lily's back?

Madge. — Knobs, all in a row.

Lily. — So do I, on Madge's back.

Holly. — It goes all up and down my back.

Teacher. — You may as well call it your backbone. It is something like this of a fish.

Prescott. — What makes the knobs?

Teacher. — Look at this. Is it one bone?

Lily. — No; it is a good many little ones.

Teacher. — You can count the knobs on your back to-night. You should find twenty-five. Each is a little bone with points sticking out around it, and a hole in the middle, through which a soft cord runs. So your backbone is really twenty-four small bones, like beads strung on a string, and each has hooks with which it holds on to the other, as they are all caught together. (Show a vertebra.) Now all bend over, and then back, very far and fast, back and forth, back and forth. Do you hear all those little bones rattle or crack as they move, and the cord strain?

All. — No, no; they don't make a bit of noise.

Teacher. — Isn't that funny? One would think they would all go creak, creak. If they did, what should you think would cure it?

Lottie. — I should think they would be oiled.

Prescott. — I should put something soft between them.

Teddy. — How is it fixed?

Teacher. — Why, God thought just as you do, and he put little soft cushions between them, and little bags of oil to squeeze against them, so that they do not rub and grate on each other.

Girls. — How good! (Boys look serious.)

Teacher. — What keeps you so firm and round, Prescott? See, when I clasp my hands on your sides and about your chest, I can't squeeze it in like a rubber doll.

Holly. — But you can down here.

Madge. — There are bones up here, and not down below.

Teacher. — Now feel of yourselves, all under your arms down to your waist. Do you feel the bones?

Lily. — I feel bars going in a ring just like hoops.

Holly. — So do I.

Teacher. — Now feel in front. Do you feel the bars there?

All. — No; it is flat and hard.

Teacher. — One flat bone in front, and hoops on each side. I brought these old bones to show you; they are the bones around a dog's chest, a good

deal like yours. I found them out in that old field by Cedar Street. They were joined to a backbone, also, at these ends. These bars are a part of the little bones of the backbone, reaching around the chest to this flat bone, — the breastbone. So your chest is all framed in, isn't it, Lily? Here is a picture of it. Some of these bones are a little soft near the breastbone: and in you the breastbone is not very hard, but it will grow harder. These bones that hoop around are called *ribs*. The other day Mr. Bliss fell from the roof of a house, and broke two of these ribs. He has to be very still while they mend themselves, and it will hurt him a good deal. If more of them had broken it might have killed him, for the parts of the body within the chest cannot bear to be hurt without killing us.

Madge. — Jennie broke a bone in her leg, the other day, and the doctor tied her leg up in pieces of wood, and she has got to lie in bed three weeks.

Teacher. — Feel of your heads. Squeeze them. Are they hard?

All. — Yes, very hard; it is all bone.

Teacher. — The bone of your head is called the skull. It is pieced together in little jagged seams

in these places, — here, and here, and here. It is a very good way to join bones together so that they won't come apart, and so that if you hit one part it won't jar the other parts as much. The cushions in your backbone save a great deal of jar, too. Just think how it would hurt you to knock the end of your backbone, if that and the skull were one solid bone. I guess it would make your head ache.

II.

Teacher. — You all examined your bodies last night, you say, to find out what bones make its frame-work. Tell me, Prescott, what you found out about your chest. See, when I feel of Prescott about here [the chest], he isn't soft, like a rag-baby, and I cannot punch him like a rubber doll. All feel of your chests.

Prescott. — There is a bone in front, and some hoops around here under my arms.

Teacher. — Just like this [illustration by drawing a model]; these hoops join the bone in front, the breastbone, and the backbone behind. See, are they separate from the backbone?

Lily. — No, they are parts of the little spine-bones.

Teacher. — They are the arms of the small bones stretched out to embrace you, and give you a place for your breath to come and go, and for your heart to beat. They are joined to the breastbone by little pieces of gristle, like white india-rubber. You have seen it in meat. Here are some below, which are more loosely hung, so that they can spread when the breath is very full. This breast-bone may be partly gristle in some of you; it will grow into firm bone by and by. The breastbone, the spine, and the ribs make a nice room for some very important parts of your body. Take a good long breath, with your hands each side of your breastbone. Do you feel the ribs push out?

Madge. — Yes'm, and I feel something push down and swell out in front. Is that a bone?

Teacher. — All breathe slowly, a strong, full breath. Do you feel it as Madge says? Well, there is a strong wall there below to this room, full of the machinery which keeps us alive. That wall is not a bone; it is called a muscle. It is a strong, elastic thing, which will stretch down and out as you need to have it. There is something

else in this nicely protected room besides the breath; feel on the left side among the ribs; what do you feel?

Teddy. — I feel a hammer. I guess they're building the wall.

Teacher. — Can you stop the hammer?

All. — We cannot; it goes right along.

Teacher. — It is your heart beating; it will never stop until you die. It goes like this [imitating the contractions with the hand], and drives the blood all through your veins; it keeps you alive, and makes you grow; it is like a hammer, building the walls; or like a clock, measuring off the seconds of your life; or like a drum, beating to call you to do what you have to do. It makes your pulse beat; put your finger here on your wrist, and feel the little hammer there.

Lottie. — That's where the doctor feels my pulse.

Teacher. — To see how your heart is beating, or how regularly and truly all the machinery is going. There is something else not in the chest to be taken good care of within the framework of bones about it. It is your stomach, which takes in all you eat, and changes it so that it can be made into

blood. The breath goes in and out of the windpipe and the lungs; the blood goes through the heart, and the food into the stomach: and all these are safely packed, surrounded and protected by spine, breastbone, and ribs. Now, stand very erect, and breathe as I move my hand, very strongly, and feel your ribs. Shall I tell you the names by which these little bones and the breastbone, also the muscle below the chest, are called? The whole backbone, made of twenty-four of these little knobby bones which link together, is the spine; each little bone of the spine is a vertebra; the breastbone is the sternum; the muscle is the diaphragm. To-morrow we will see about the bones of the arms and legs, hands and feet; and about the joints, or how the bones move upon each other.

Ethel. — The bones you show us are very dry and rough. Is that like our bones?

Teacher. — No; they are old and dried in the sun and weather; all the oil is dried out of them, and they are brittle. Your bones are softer and smoother, and more elastic; they will grow harder and more dry and brittle when you are old. What are they at all like?

Teddy. — Something like chalk.

Teacher. — Yes, and they *are* like chalk; they are made of lime very largely. Have you any opportunity to look at your own bones, to see whether they are like this?

Ethel. — I hope not: not unless we cut our flesh.

Teacher. — Prescott came in from recess yesterday, with one of his bones in his hand.

Prescott. — Oh, my old tooth! I threw it away.

Madge. — Are our teeth bones?

Teacher. — Well, what do you think?

All. — Oh, yes, they are.

Lily. — But they are very smooth.

Teacher. — They are dressed up a little to show, with a nice, hard polish on the outside, called the *enamel*, which protects the bone.

III.

Teacher. — As you go through your calisthenics I cannot help thinking how easily and rapidly you can bend your arms, your wrists, your fingers, your knees and ankles. How is that, Madge? will your bones bend anywhere?

Madge. — No, no; my arms will bend only at the elbows.

Teacher. — How do you whirl your arm around like a wheel, in this movement, then?

Madge. — Oh, it moves at the shoulder, too.

Holly. — And at the wrist and fingers, in two or three places.

Teacher. — These places are the joints. Now, all try your shoulder-joints; can you move them up or down, or backward and forward?

Prescott. — I can move them up and down, back and forth, and round and round.

Teacher. — The joint is like a ball in a cup, in which it can turn almost every way. The end of the arm bone is a ball of bone covered with the smooth, elastic skin called cartilage, as all the joints are, and the shoulder is fitted together to form a cup, in which the ball is held by firm elastic cords so that it will not slip out, but can turn in any direction. How convenient it is to swing the arm when you throw, and how important this free movement for the use of the whole arm!

Holly. — What are these bones at the shoulder?

Teacher. — There is a large three-sided bone from the back, called the shoulder-blade. You can

see it plainly as you push back the arm at the shoulder. There is a bone plainly seen also on the front of the neck, called the collar-bone. These two bones join at the shoulder, and their united edges form the cup. The collar-bone is fastened to the breastbone, and the shoulder-blade to the backbone. Can you all feel these bones plainly?

All. — Yes, very plainly.

Teddy. — Stan broke his collar-bone one day, and it mended with a crack in it.

Teacher. — It ought to have mended better than that. Wasn't it well fitted together?

Maggie. — Well, Mrs. H., he tried to kick football before it was quite well, and he fell down and broke it again.

Teacher. — He ought to have kept still until it was firmly knit together. But it isn't a very severe thing to break the collar-bone; not at all like breaking one of the large bones. You see how small it is. Now all see how many ways you can move the elbow.

Lottie. — Only up and down.

Teacher. — What kind of a joint will move only one way? Try the door. What is that which makes it swing back and forth?

Prescott. — It is a hinge. Is that the way our elbows are made?

Teacher. — Yes; very much. The elbow and fingers have hinge-joints. Make them all go. You know we have to oil hinges occasionally, so our joints are constantly oiled from little bags near them, which squeeze out oil when the joint works. What other joint in your body is a hinge-joint?

Carrie. — My knee, I think.

Teacher. — Does your knee feel like your elbow?

Madge. — No; my knee is flat and my elbow pointed.

Teacher. — The joint of the knee is covered by a little flat bone to protect it; the bone is the knee-pan. You can make it knock against the point by striking it, and it sounds like money. Try it.

Prescott. — I can make you think I have money in my hand.

Teacher. — So the knee is a hinge-joint. How many ways do you find it to work?

Teddy. — It goes up and down.

Teacher. — Now try your toes. Can you move them like fingers?

Ethel. — Only a little; but when my foot is bare I can do it pretty well.

Carrie. — Baby moves hers all round and sticks them all apart.

Teacher. — I heard of a man who could sew and knit with his toes, and of one who could play on the piano with his.

Madge. — Why could he?

Teacher. — He had practised it a good deal, because he had no arms. If we practised moving our toes we could do much more with them than we think. Any joint or other part of the body will work more freely by exercising it. Whatever we try to make the body do, it will come to do in time; it will obey our will if we train it. Now try your wrists and ankles. Move them every way you can.

Agnes. — Why, they will go any way you try.

Teacher. — They are quite different from the other joints. Take off your round gold beads, Gertrude, and they will roll on each other any way: I put them in two rows and see how they may turn about. The wrist and ankle have two rows of little bones, four in a row, upon which the hand turns; the movement is easier and more

varied than the ball and cup joints. When Louie plays on the piano see how many ways and how quickly she can throw, turn, or twist the hand. It is the smooth rows of little bones that do it. It is much worse to break the wrist or ankle than the collar-bone, and takes a long time to heal the break and make the joint strong again.

Maggie. — Yes ; it is a year since mamma broke her ankle, and it isn't strong yet.

Teacher. — Be very careful of the ankle and wrist — and of the knee, too. When these joints are hurt, some trouble is apt to occur, because they are harder to reach than some of the other joints. The socket at the hip is formed by the meeting of two strong large bones which support the body. Your backbone is like many hinge-joints ; your shoulders and hips are ball and socket joints ; your elbows and knees, as well as the joints of your fingers and toes, are hinge-joints, and your wrists and ankles are rolling joints. Now can you all repeat this ?

All repeat it correctly, and then all the class are allowed to try moving as many of their joints at once and as rapidly as they can, which ends the lesson.

IV.

THE class should be allowed to see a manikin during the study of the bones, and be led to observe all the bones and joints carefully.

Teacher. — We have learned what the framework of the body is, and how its different parts are joined together for our convenience. Do you think it like any other skeleton?

Teddy. — It is made something like a monkey's.

Prescott. — It is like animals, a good deal.

Teacher. — So it is, but it stands upright, and has two arms instead of two fore-legs. Nevertheless, it is on the same plan as that of all four-footed animals; you can easily see the likeness and the difference. The long chain of bones in the back, the spine, is the same, and gives a name to all animals that have it; they, with man, are called the *vertebrates*, from the name of each little bone of the spine, *vertebra*. (Let the class name a variety of vertebrates.) Is this framework of bones inside or outside of us?

All. — Inside.

Teacher. — Are you not glad that it is clothed,

and made beautiful with flesh and skin? What is the flesh?

Madge. — It is the part that has blood in it.

Prescott. — It is the part we eat in animals, — the meat.

Teddy. — It is the thick part around the bones.

Teacher. — You are *all* right. At recess I will take you over to the meat-market, and show you how it is wound about the bones and lies close to them, with a thin skin around it which twists into strong cords at the ends, and fastens the flesh tightly at the joints. What are the cords and the flesh for, do you think?

Lottie. — To cover the bones.

Teacher. — Did you ever take a chicken-leg from the kitchen, and pull the end of a tough white cord, showing just where the joint was cut?

Ethel. — I have, and it pulled up the claws, and acted just like walking.

Teacher. — The cords at the ends of the muscles do the same thing; they move all your joints, pull the bones this way or that, as you wish. The muscle, — that is, the flesh which is wrapped about the bones, — is shortened, and brings up the cords to pull the bones; I cannot fully understand it,

but when you wish your arm to come this way, your muscle knows it, and shortens to pull up the arm; it is as if your mind up here in the brain sent a telegraphic despatch to the muscle to pull up the arm, and it did so. God understands it, who made it. There are little fine threads going from the spinal cord which joins the brain, and these threads are like the telegraphic wires; they carry the message of the thought and will, and are called nerves.

Agnes. — I never heard of anything so nice as that!

Teacher. — You didn't know you had a thousand telegraphic wires in you; but these little nerves go to every spot in your body; if you prick any part with the finest needle, the message goes by the little fine nerve that reaches that spot, all the way to the spinal cord and to the brain, to tell your thought where it is, and you can tell at once, without having seen, where it is. Suppose it were not so, how often we might be hurt without knowing how or where, and perhaps we might even be killed without a chance to prevent the fatal effect of some little wound.

Willie. — I felt something hurting my hand, the

other day, and looked, and found a piece of a needle almost hid in the flesh by my thumb, and my father got some pincers and pulled it out.

Teacher. — These little nerves tell the *muscle* what to do, and then the muscle shortens or lengthens and does it. All draw your arm up and forward from the elbow; shut your hand tight, and feel of the muscle. Can you feel it?

Madge. — Papa laughs at my muscle; his is just as hard as iron when he does this, and bunches right out.

Prescott. — I can show my muscle; it is hard, too.

Teacher. — See how firm your muscle is on the lower part of the leg, the calf of your leg. That is large and strong, because you use it so much, jumping, running, skating, and walking. The muscles grow round and firm by using. They are all over you. Did you see the men at the circus, who leaped so well and performed on horseback? Their muscles were all well developed, and looked as they ought to look, and made the whole body very handsome and graceful, and agile and strong. You must exercise all the muscles, to make your body grow as it was meant to grow.

There are great bands of flesh or muscle across the chest, and they ought to be strong and make the chest round, the body erect, and bring the shoulders back. Stand up as you think you ought to look. Now take a good, long breath. If your chest-muscles are strong, you can breathe better; and you remember I told you about a strong muscle which separates the chest from the lower part of the body; that is the diaphragm, — and when you breathe it swells out and draws in, and moves up and down. Do you feel it?

All. — I feel it.

Teacher. — When you use the muscles, the blood rushes quicker into the little veins, the blood-vessels, which are just like a fine net-work all over the body and through all the muscles. The blood keeps the muscles warm and alive, for it carries something to them to build them all the time, as they waste from using, and it carries back the wasted parts, which would decay and corrupt the body otherwise, and that is just what happens when a creature dies — the flesh decays; you all know this. We will go and see the flesh at recess, and I will show you how it lies about the bones and is tied to the joints, and you can think

that it is very much the same as your flesh, which is so much of your body and does so much of your work.

V.

Teacher. — Madge, we went over the rope-works, yesterday, to see the machinery. What room did you think contained the most important part of it all?

Madge. — The room where the engine was, for that keeps it all going.

Teacher. — True; and if the engine is taken good care of, and kept going just right, every wheel will do its work and all will go on as it should; but if the engineer neglects his duty, or has not the skill to manage the engine, some bad accident or disorder might result. How nice the engine was! and the room was quite clean, and the men there were busy and attending to their work. Now, all put your hands on your heads. Your head is your engine-room; in it is the engine — the brain. How solid the walls of the room are! Where are the doors, and windows, and the belts which go to turn all the wheels, and keep your whole body-factory at work?

Esther. — The eyes are the windows.

Prescott. — So are the ears.

Teacher. — Through the eye and the ear come to the brain the light and sound of what is outside the body; through the nostrils and tongue, the smell and taste; through the skin, the feeling. All these are called the "senses." (Enlarge upon these *ad libitum.*) But how does the brain communicate with the rest of the body? How does it get news of any hurt or any good to the rest of its body, or send any message to other parts of the body, such as a message to the arm to move, or to the feet to walk?

Lottie. — You told us there were a thousand telegraphs to carry messages back and forth all over the body.

Teacher. — Yes, these are the nerves. The brain and the spinal cord, and the nerves are all one, like a root and stem and branches. All together they make up the nervous system. I went into a Surgical Museum once, and in a glass case I saw an exact representation of the nervous system of a man by itself, separated from all other parts of the body, as if it had been drawn out and hung on a hook by the brain; down from the base

of the brain behind hung the spinal cord, and from it hung the principal nerves of the arms and legs, with all the hundreds of little thread-nerves running from every part of it. It was a curious looking thing.

Teddy. — What color was it?

Teacher. — If you could look inside your skull, your engine-room, you would find it packed quite close with soft gray coils and bunches. This gray mass is the brain; it pushes its substance down through all those little holes in the spine, — the middle of the vertebræ, you remember, — and sends out threads all over the body from between these little bones. The brain is the tool of the mind.

Ethel. — I thought the brain *is* the mind.

Teacher. — When your body dies, the brain will die, too. You could see a dead brain, of no more use; but the mind is still alive, and I am sure must have a better tool or machine than the brain, although that is better and nicer than any made by man. Does this machine or engine ever get out of order?

Maggie. — When a man is crazy, is it out of order?

Teacher. — Yes, and do you not think that is almost the worst thing that could happen to us, that our mind should be out of order, as we say, when the mind cannot control the brain?

Mabel. — Oh, yes; for then we might kill ourselves or somebody else.

Teacher. — Sometimes the brain is hurt, or sick, and that is often fatal, — always very hard to cure. If a man falls and cracks his skull and knocks a piece of it against the brain, or wounds or inflames the brain; or if he uses or excites the brain too much, so that it becomes too tired, it is a very serious matter, and very hard to cure; but if it is the connection between the mind and the brain that is affected, then it is called insanity, and the man is like a workman in a factory whose engine is all out of order, and nothing can be relied upon; his machinery may kill him, and everything may go contrary to the rule. Should you be careful of this engine?

Prescott. — Very; but how?

Teacher. — Do what keeps the whole body healthful; the brain is a part of the body; also let the brain rest when it is tired. Let it work well and regularly when it works, and go to sleep when

it is tired. When it is too tired to work, sleep comes like a night-watchman and shuts up the doors and windows, and the engine stands still The mind lets it alone and it gets rested. You saw the rope-works' engine resting, and a man was oiling it and polishing it and getting it all in good order for work. That is what sleep does for the brain.

Gertrude. — How does the brain work?

Teacher. — I don't know that I can tell you. There is, probably, some movement of a particular part of it for every kind of work. Now, try to remember something. A certain part of the brain moves now, and you remember. Now try to understand something hard; another part of your brain works, and you understand. The action of any part of the brain strengthens that part, just as I explained that the exercise of a muscle strengthens that muscle. Make your mind do what is hard for it to do, and it will do that easier the next time; so you improve different parts of the brain and cause it to grow.

Your mind will become weak if you do not use it, just as your muscles would. The will is the controlling force of the body, and the mind is the

power that uses the will. The mind ought to govern and use the brain perfectly, and that is what I am trying to train your minds to do. The mind can control not only the brain, but the whole body, much more than you think, and keep it well and make it work well. What you will to do, you can do.

VI.

THE SENSES.

Teacher. — I told you about the brain, which I called the engine. Everything in the body has to be connected in some way with the brain; all knowledge of the outside world, all means of reaching outside things, of doing or learning, must come in different ways to it. What ways do you think of, Sallie, by which you can learn about this flower?

Sallie. — I can see it.

Teddy. — I can smell it.

Teacher. — How do you learn of the cricket, which we do not see, but which you know is near?

Prescott. — I hear it chirp.

Teacher. — And if I tell you to shut your eyes and open your mouth, and put *this* into it, what is it?

Amy. — It is a grape. I taste it.

Teacher. — Once a little girl had the scarlet fever, and it destroyed her sight, hearing, smell, and taste, and it seemed as if she could never have any way of knowing or doing or enjoying anything. Her body seemed like a close-shut prison for her mind. But there was one way left open, and a good, wise man took that way, and through it taught her as much as many a person learns through every sense of a perfect body. She is highly educated now, and has lived a happy and useful life. What was that one way left to her to find out about outside things?

Teddy. — She could feel of things.

Teacher. — Now name all these ways from the brain to the outside world.

All. — To see, to hear, to smell, to taste, to touch.

Teacher. — These activities are called the *senses*, from a word meaning *to feel*, because every act of the senses is a touch of the organ of sense upon what is brought to it. The eye is touched by waves of light, the ear by waves of sound, the nostril by perfume, the tongue by flavor, the skin by what is in contact with it. All these

parts *feel*, and the brain takes knowledge of what is felt. Name the *organs of sense.*

All. — The eye, the ear, the nose, the tongue, the skin.

Teacher. — The fingers have a very delicate and wise sense of touch, although the whole surface of the body can observe in the same way. In using these senses we ought to take pleasure, as it is intended that every healthy action of the body should give more or less pleasure; but we must never take more enjoyment in the mere action of the senses than in the purpose for which they act. You should not eat for the mere pleasure of taste when you do not need food. You should never use an organ of sense until it is weary, or until you cannot at once stop using it when it has done your work. You must control your senses; be their master, and not their slave. It is a sad thing when even a child cannot control his senses. He cannot be trusted to take care of himself. A man who is the slave of his senses is a brute, bad and degraded in character. The senses must always obey the reason and conscience.

Ethel. — Where is your conscience?

Teacher. — That is a part of the soul. We

cannot place it. It tells us what we ought to do or ought not to do. If we obey it, it will be faithful, and grow more and more clear and decided; if not, it becomes uncertain. It is the *sense of the soul*, as reason is the sense of the mind. The senses of all grow more delicate as we use them and do not abuse them. We must take good care of the organs of sense. The eye, for example, is so delicate and easily hurt: what protection has it?

Esther. — The eyebrows hang over it, just like a porch.

Gertrude. — I have often thought the eyelids are like fringed curtains to cover it. They open and close so quickly, before you can think of it.

Teacher. — You have a little fountain of salt water to wash it with. We will take the *eye* for another lesson.

VII.

THE EYE.

Teacher. — Each of you look at your neighbor's eye steadily. Is the eye flat or rounded? It is rounded. Yes, it is a ball. You may have seen

a fish's eye: it is smooth, hard, and slippery. Do you see a little mirror in the middle, with your own face reflected in it? You do. That mirror is a little, convex, transparent surface, like glass, over the open end of a tube that leads into a dark chamber, where any impression of your face is spread upon the walls as it is upon the photographer's plate, and that picture is carried by a nerve to the brain, which perceives it and sees your face. So it is with all that is before the eye. That black hole is called the *pupil*, the glass-like surface over it the *cornea*. Do you see the blue, or gray, or brown circle outside the pupil? That is the *iris*. It shows little muscles to draw the edges closer together and make the pupil larger when it grows darker so as to give room for more light to go into that dark chamber and make the picture clearer on the walls. What else do you see, Alice?

Sallie. — I see the pupil grow smaller and the blue part grow wider.

Teacher. — There are some other circular muscles which draw the iris up over the pupil like strings in a bag, when the light is too strong. Roll your eyes around. Can you?

All. — Oh, yes! every way.

Teacher. — There are muscles and cords holding the round eyeball in its socket, which can act like the cords and muscles in any part of the body and turn the eye as we will. Did you ever see a person cross-eyed, or with eyes turned too much toward the nose? Something was wrong with some of the muscles, in that case. If you use your eyes too much, you may hurt these muscles; if you hold your book too near, you will hurt the eyeball, making it grow convex. If you keep glancing too rapidly from a distant to a near object, you will tire and weaken one of these muscles and grow more and more near-sighted. Always heed the caution of those who have had experience in troubles of the eyes, for it is such a terrible thing to have the eyes hurt or impaired by abuse. Hold your head up naturally as you sit erect, and read with the book at just that distance where you read easily. Do not read or look with one eye only, but with two, as is designed for you. Bathe the eyes with fresh, cold water; open them in water every day; rest them when they feel tired. If you are at all near-sighted, practise looking at distant objects. Do

you see the little blood-vessels roll over the eyeball?

All. — We do.

Teacher. — Don't touch the eyeball. See how hard the eyelid tries to prevent you. It is not meant to be touched. Never try to read or work by too dim a light, nor to look directly at a very bright light. Why do you have two eyes?

Prescott. — To see all round a thing.

Teacher. — If you look with one eye, a thing looks more flat; with two eyes we see it from two different points at once. Look at this stereograph, — two pictures of one thing, — are they exactly alike?

Lottie. — This one has more of the house on this side of the picture.

Teacher. — Do you all see that there is a very little more of one side in one picture, and of the other side in the other picture? That is the difference between the thing we see with our two eyes. Try experiments, first with one eye and then with the other. You find you do see things a little more or less on one side, with either eye. So we get a truer view of the whole thing with both eyes at once. The nerve which

carries the picture to the brain is the *optic nerve;* it has a branch to each eye. There are two little transparent lenses for the rays of light to pass through before the impression reaches the optic nerve. You must learn more about light, and how it waves, before you can understand fully how the image which passes into the pupil through the convex lens over it, the cornea, reaches this nerve.

VIII.

THE SENSE OF HEARING.

Teacher. — The ear is a strange-looking part of the head, somewhat like a little trumpet attached to the side of the head.

Carrie. — It looks like a shell.

Teddy. — Does the opening go way into the head?

Teacher. — No; you would find something very soon which would stop the way; it would look like a little round white membrane, as it is, like the parchment of a drum stretched over the opening; it is delicate and thin, about so wide; it

quivers or vibrates when sound strikes it, just like any stretched surface; it vibrates with the sound-waves of air, and that vibration is carried through it to four little bones which are in an open chamber behind it; they carry it on through a spiral passage very much like the windings of a snail-shell, until it reaches the nerves, which carry it to the brain; when the brain receives the impression, or knows of the vibration, *sound* is the result. Why do you think the external ear is shaped so curiously?

Ethel. — To get all the sound it can.

Teacher. — The vibrations of the air, which are waves of sound, are gathered up in the expanse of the outward ear and transmitted gradually through quite a tube without sudden shock to the delicate drum of the ear. This drum is so delicate as to repeat the vibrations very truly to the queer little bones which touch each other behind it, and the vibrations are carefully carried on, winding gently to the connections with the nerve which perceives it for the brain. Very nice care has been taken that we may hear. If you should see the whole machinery of the ear, you would wonder at the wise contrivance.

Fanny. — Why cannot Alice hear as well as we? Her ear is just as good.

Teacher. — Alice had scarlet fever once, which destroyed the drum of the ear, as it often does, breaking it down by some very poisonous matter which was near it and which had no other way of escaping from her blood. It pierced this delicate little drum, and wore it away entirely in one ear, and nearly all in the other; yet the little bones are left, and the vibrations of the air reach them through the bones of the face and head where it touches them. Alice can hear a little when she opens her mouth.

Alice. — I know I can; or if the piano is playing, I can hear better leaning upon it. Why?

Teacher. — The vibrations are carried through the mouth and by the teeth or by the arm to the bones of the face, or through tubes leading from the throat into the chamber of the ear where the four little bones are. The outer ear is a protection to all the nicer and interior parts of the organ of hearing. A waxy substance surrounds the tube of the outer ear to keep out anything which might otherwise touch the drum. We should never put anything hard or sharp beyond this, for fear of

piercing the drum. Some sound-waves are so strong that they are perceived also by other parts of the body, as for instance the firing of a cannon or heavy thunder, making the whole air shake; but the ear is especially arranged, — made exactly so as to gather and carry the delicate vibrations of usual sound, which we could not otherwise know. Now let us attend to the sense of smell. What is its organ?

Answer. — The nose.

Teacher. — There is something which we call perfume; it would be hard to say what it is; sometimes it is agreeable to us, and sometimes not. We cannot tell why, but it is very decided.

Hattie. — How queer it is! I am trying to think what perfume can be, but I am not able to explain it.

Teacher. — Now suppose a little flower, tuberose or heliotrope, is here. Why, it sends its perfume into every spot of the air in the room instantly. You perceive it at once and everywhere, and will as long as the flower lasts in the room. If I took the flower out of the room, should I take the perfume out too?

Maggie. — No, you would leave what was already in the room still there.

Teacher. — Would it give less perfume in another room, then.

Daisy. — No'm; just as much until it is withered.

Teacher. — Isn't it very strange? Something escapes from the flower as long as it lasts; without taking time to travel, without making the space of the room any less, it fills every part of it, telling us of the character of the flower. One little drop of attar of roses will send its odor through a bottle as tightly sealed as we can seal it, and pervade everything it reaches with such a strong scent that it seems almost impossible to destroy it. What a wonderful quality! It reaches our brain through little nerves spread out upon the inside of the nostril, and we have the sense of smell. The sense of taste is almost as curious, but as it requires contact of the organ of taste, the tongue, with the substance which is tasted, it does not seem quite so impossible to understand. Look at each other's tongues. Look through this magnifying glass. How wonderful! A little forest! The surface of the

tongue is covered with little feelers which almost seem alive, and the flavor of what we taste comes to these so as to be conducted by the nerves which run from its surface to the brain. Thus we taste. The senses of taste and smell may both be injured or deadened by illness, or by abuse. They are intended to guide us in our choice of food and other things used by the body. They will guide us if they are in a healthy state, but we must not excite them too much, or train them to wrong uses. Can other animals use any of these senses better than we?

Willie. — Dogs can smell better. They can follow a man by his scent.

Prescott. — Setters can scent game, and show the hunters where to look.

Teacher. — Animals may have some senses we do not understand. These of which we speak are the human senses. Feeling is the perception by contact with any part of the body, for the nerves of touch come to the surface everywhere, but chiefly in the fingers, which can be made very keenly sensitive by practice, as in the case of the blind.

IX.

VITAL ORGANS. — THE HEART.

Teacher. — I have told you somewhat of all parts of the body except those which are kept in the two chambers within its outer frame. Put your hands upon your left sides, gently pressing. What do you feel?

Teddy. — I feel the little hammer that pounds all the time.

Teacher. — Do you have to keep that hammer sounding or beating by your own thought or will?

Blanche. — No; it goes itself.

Teacher. — Here is the heart of a calf. Let me show you how it is made; for yours, which is what you feel beating, is much like it It has these two sides, one which fresh, red blood goes through, and one which the impure, dark blood, returning from its course through the body, fills. The heart is like a pump; it forces good blood, which has been purified, through numberless tubes, called *arteries*, to all parts of the body, to build it and feed it; then it receives that blood which has become impure, back through as many

tubes, called *veins*, and sends it into another organ to meet the air, which changes it to pure blood again, after which the heart again receives the blood and forces it once more through the arteries; and so this goes on as long as we live, the heart forcing the blood through arteries and veins by this action we call "beating," like the motion of a hand squeezing and opening with great force and regularity. There are little doors in the heart which open and close as the blood rushes through, and assist in keeping its direction the same. There are little doors, called *valves*, in the calf's heart. They are so nicely arranged that the blood cannot go the wrong way. They open and shut, open and shut, with every squeeze of the heart. You would wonder to see the force with which the heart sends this current of blood through the body. The blood flies swiftly around, leaving fresh life and substance for every muscle and nerve, and taking away the waste particles that need to escape into the air. If you should cut an artery, the blood would spout out like a fountain, and if it were not checked very soon you might bleed to death. This heart is necessary to life. It is

placed in great safety within the chest. It has strong muscles to contract and dilate with unceasing regularity and great forcing power. If it is injured, death will result. The flowing of the blood through the heart, arteries, and veins is called its *circulation.*

THE LUNGS.

Teacher. — The organ into which the blood comes to meet the air and be purified by throwing off its waste particles, is a double organ, called the lungs. It is within the chest, like the heart; it is the organ of breathing. Do you have to breathe?

Daisy. — I can wait a moment without breathing, but then I have to breathe again.

Teacher. — The action of the lungs, as well as the heart, is involuntary. You do not need to think of it or will it. It goes on regularly as long as we live. It is necessary to life, and the lungs are therefore a vital organ. I must also show you the lungs of the calf, and you will understand, better than I can describe it, how your own lungs look and act. Here are the two,

like red sponges, attached to tubes which are branches to this larger tube called the *windpipe*, since through it the air comes and goes into the mouth and nostrils. These two lungs will swell when the air fills all these little holes or cells. Now take a good, full breath. Do you feel the lungs swell within the chest as a sponge swells in the water?

Dolly. — I do; and they push down and forward and make me grow large.

Courtenaye. — I feel the cool air coming into my mouth and nostrils when I do it.

Teacher. — The blood comes into a thousand little veins which line these air-cells of the lungs, and all that is bad in it escapes into the air in the cells, and it receives the life-giving part of the air, which makes it fresh and pure to go back again through the heart to the body. When the blood, thus cleansed, leaves the lungs, the air which has cleansed it returns through the tubes and windpipe, through the nostrils and mouth, to the outside air; this breathing in and breathing out is repeated with every movement of the heart and lungs as long as we live. Thus the blood is kept pure, and the body renewed and alive. But you

can see at once that the air about us is hurt by the escape of this waste from the lungs; we must have fresh, pure air about us all the time, or the blood will not be purified enough by breathing. Some air is more life-giving than other. You feel brighter and stronger in it. Out-of-door air is the best. If you wish to keep well and be strong, you must breath fresh, clear air. It will make the blood red and give you rosy cheeks. You must hold yourself erect and wear nothing tight, so that the lungs and heart can act freely and work well. But do not run when you breathe too fast or when your heart beats too hard. Never overwork the heart and lungs by too violent or too long continued exercise, like jumping rope too long, or running when you are out of breath.

THE DIGESTIVE ORGANS.

Teacher. — There is another organ which is necessary to life, not within this upper cavity of the chest, but in a second cavity below the *diaphragm.* It is the *stomach.* Here is the stomach of a pig and it is very much like yours. It

is a kind of bag. This tube which comes into it from above is the *gullet* and opens from the back of the mouth. The stomach is the place where the food is made fit to be changed into blood. You can tell me a good deal about the food you eat, as it is made ready to enter the stomach. Grace, if you are hungry, that is when your stomach calls for food, what do you do with the food you have put before you?

Grace. — I put it into my mouth; then I chew it.

Teacher. — When you chew it, what wets it?

Grace. — Some water comes in my mouth.

Teacher. — There are three little sacs opening into the mouth, under the tongue and within each cheek, that squeeze a juice called *saliva* into the food to make it soft. As you think of it, the juice starts from these sacs called *glands*, and you say your "mouth waters."

Prescott. — My mouth waters for an orange.

Teacher. — Elsie, what cuts up the food in your mouth?

Elsie. — My sharp teeth chop it all up fine.

Teacher. — How do you stir it about for your teeth to chew?

Edith. — My tongue rolls it around.

Teacher. — After it is all fine and moist you swallow it. A little trap-door opens to let it go into the gullet, and it is pushed along through the gullet by these little ridges partly opening and shutting, until it reaches this door opening into the stomach. When it is safe within, it will stay there if it is good and well prepared, but if it is only partly chewed, or will hurt you, after a little while the stomach throws open its upper door again and sends it up the gullet and out of the mouth in a hurry. This makes us feel sick, and is very unpleasant; but it is better than to keep it in the body. You must be careful, then, what you eat, and how you eat. You will be told what will hurt you, what you must not eat; and you must not eat too fast and swallow great bits without thorough chewing with your sharp teeth. Do you like to eat, Teddy?

Teddy. — Yes, when I am hungry, or have something very nice.

Teacher. — How stupid it would be to eat if we did not enjoy it! We should forget or neglect it,

and our bodies would have nothing to make blood of; but our sense of taste makes it pleasant.

Now the good food stays in the stomach two or three hours and is stirred about by the movement of the muscles of the stomach, and mixed with a juice that comes from the lining of the stomach, called the *gastric juice*. After this it is soft and gray, and ready to go into another part of the food-organs, the *bowels*, which are in the same cavity of the body, called the *abdomen*. In this cavity, which is less protected than the chest, are the *stomach*, *bowels*, the *liver*, the *pancreas*, and some other organs not belonging to the change of the food into blood. While the food is in the bowels, juices from the liver and from the pancreas mix with it. A greenish yellow juice, called bile, comes from the liver, and the food is changed, while it is passing through the long, coiled tube of the bowels, into something thin and white which is drawn from the bowels through little tubes into a larger tube which empties it into the heart to be mixed with the blood.

This is the way by which your lunch which you may now eat is changed into blood that can

become a part of your body, and all these organs which work upon it are called the *digestive organs.* Breathe good air, sleep, rest, exercise, eat and play well, and you will be well, happy, and useful, and, I think, *good.*

NOTE. — Observation lessons on minerals are laid down by the course of study for grammar schools. The following "Science Guides," issued by the Natural History Association, will give all needed directions for lessons and material:

1. ABOUT PEBBLES. — Hyatt.
2. COMMON MINERALS AND ROCKS. — Crosby.
3. FIRST LESSONS IN MINERALS. — Richards.
4. THIRTY-SIX OBSERVATION LESSONS ON COMMON MINERALS. — Clapp.

Some assistance in obtaining a collection of minerals for any Boston school may be obtained by application to the Supervisor of Elementary Science.

PART FOURTH

PHYSICAL EXERCISE AND MANUAL TRAINING

PHYSICAL EXERCISE AND MANUAL TRAINING

CHAPTER I

PHYSICAL EXERCISE

ALTHOUGH the natural games and activities of childhood furnish the best physical exercise, under the most healthful stimulus, *viz.*, the spontaneous and pleasurable excitement of sympathy and friendly emulation, yet where these cannot easily be indulged in, or where the circumstances of city life are too unfavorable, other modes of attaining the object must be resorted to.

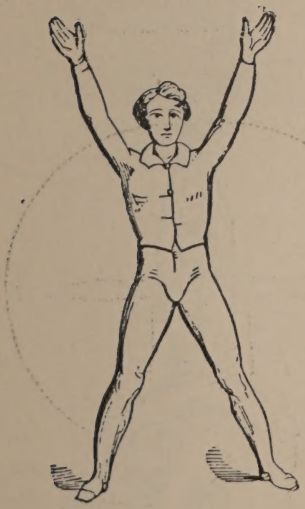
It should be remembered that the primary object of physical exercise is the re-invigoration of the whole system, through the expansion of the lungs and the impulse of free and full circulation of the blood. No exercise is of real value that does not increase the breathing-power, and quicken the action of the heart, so as to fill the arteries with pure blood and distribute it, with increased energy, to every organ of the body.

Light exercises of various parts of the body are of little value except as performed for a diversion, while some posture is held which expands the chest and abdomen. The Swedish system of physical exercises, arranged by Ling, is generally regarded as having

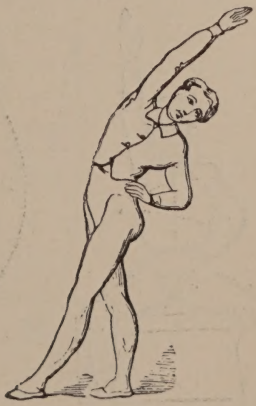
very important merits; the main principle of starting invigorating forces to the vital organs underlies all its movements. When the limbs are extended in any direction, they are to be also stretched gradually in that direction; every movement is to be undertaken with deliberation and mental attention; the movements are carefully graded, and are so effectual as not to require a long practice at one time; every movement is designated by a phrase which can be used as a word of command. The course of exercises is adapted to an harmonious development of the whole physical system, so as to result in a fine and easy carriage of the body, and perfect control of every muscle, producing grace and freedom of movement as well as health and vigor. Some of the exercises are here given; any of these could be practised in the schoolroom, most of them by the class in concert, and equally by boys and girls; yet the teacher may select from them such as are most practicable for general use, and arrange a series for each day in the week or month. They are not to be given with music, and require no apparatus. They can be closed with marching to music for a few moments, if desirable. In marching, a good carriage of the body and head, and steady and well-directed movement of the legs, should be required, with a general military bearing.

The following cuts delineate some of the main features of the Ling gymnastics which are practicable in the schoolroom; they are, however, not to be applied except by a thoroughly trained teacher, as it is of the highest importance that these gymnastics

should be used according to a thorough knowledge of the system both theoretical and practical, and adapted skilfully to the wants of various classes. Marching on the whole foot or on the toes, rising as well as running on the toes, are frequently introduced as part of the exercises; also stretching the arms outward, inhaling, and letting the arms drop slowly to the sides while exhaling; these exercises relieve the body. Perfect attention to every order and movement is required, as they are not given in an unvarying series, and are not rhythmical.

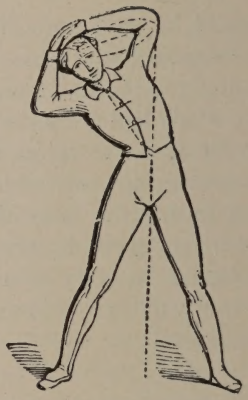


UPWARD STRETCH. FEET APART. FEET TOGETHER.

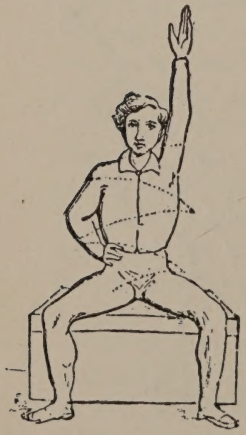


UPWARD STRETCH. SIDE BEND. TRUNK ROTATE.

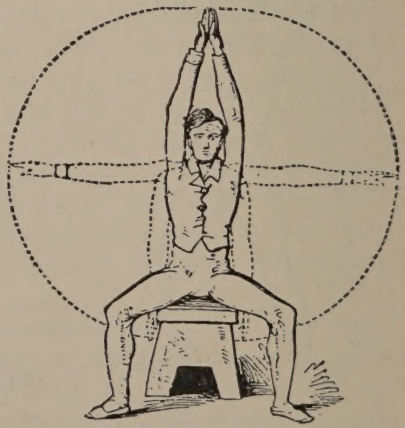
OUTWARD STRETCH. BACKWARD BEND.



SIDE BEND.



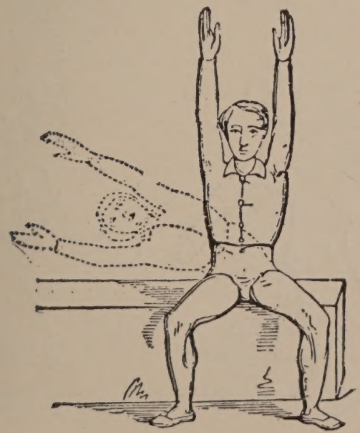
ALTERNATE ARM STRETCH. SITTING POSTURE.



ARM STRETCH. SITTING POSTURE.

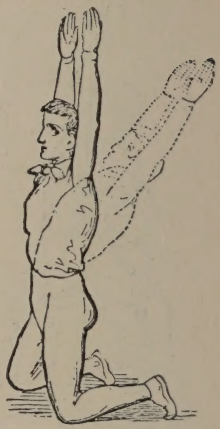
ALTERNATE ARM STRETCH. SITTING POSTURE.

ARM STRETCH. FORWARD SIDE BEND. SITTING POSTURE.



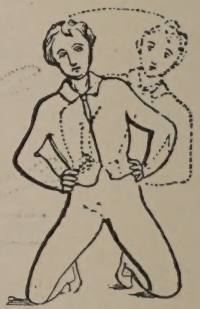
ARM STRETCH. BACKWARD SIDE BEND. SITTING POSTURE.

UPWARD STRETCH. BACKWARD BEND. KNEELING POSTURE.

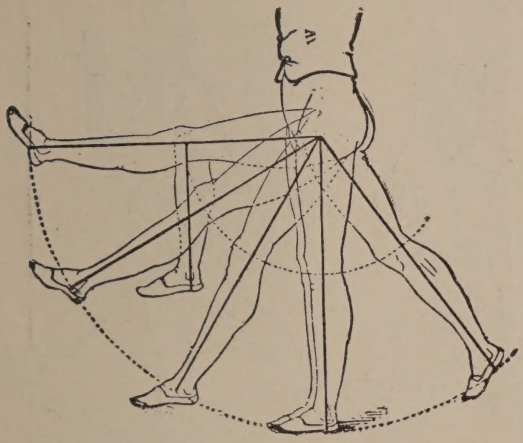


UPWARD STRETCH. BACKWARD BEND. KNEELING POSTURE.

FORWARD STRETCH. BACKWARD STRETCH. KNEELING POSTURE.



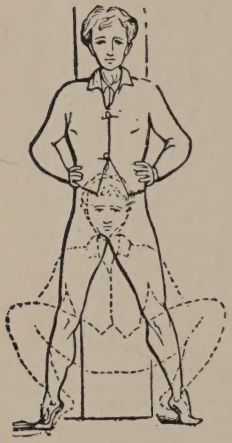
SIDE BEND. KNEELING POSTURE.



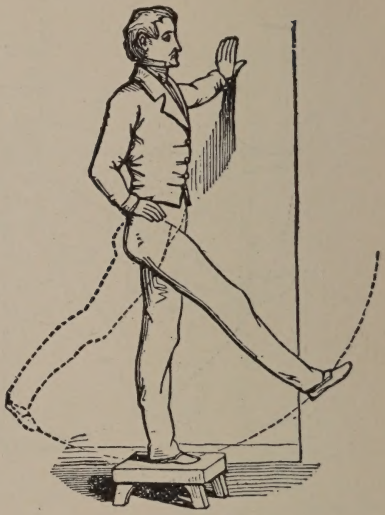
LEG STRETCH. LEG BEND. STANDING POSTURE.

ALTERNATE KNEE BEND. BACKWARD MOVEMENT.

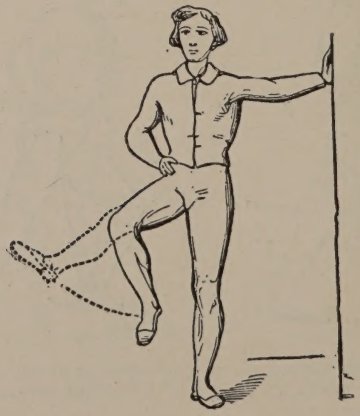
ALTERNATE KNEE BEND. FORWARD MOVEMENT.



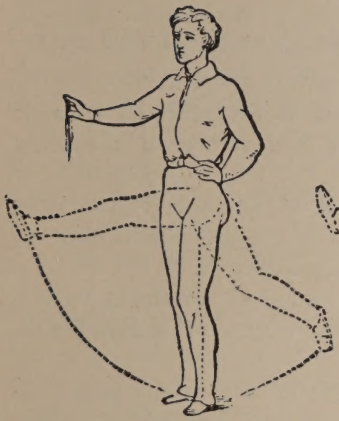
TOE SUPPORT. KNEE BEND. TRUNK RAISE AND LOWER.



ALTERNATE SIDE SUPPORT. LEG SWING.

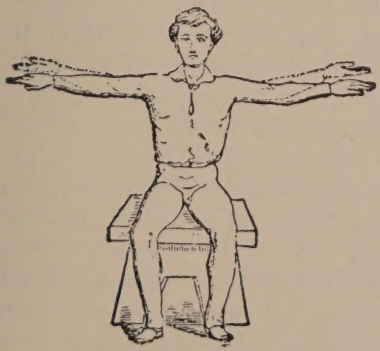


ALTERNATE SIDE SUPPORT. LEG MOVEMENTS.



SIDE SUPPORT. ALTERNATE FORWARD KICK. STANDING POSTURE.

ALTERNATE FORWARD KICK. SITTING POSTURE.



ARM STRETCH. TRUNK BEND. SITTING POSTURE.

EXTRACT FROM THE REPORT OF THE BOARD OF SUPERVISORS ON PHYSICAL TRAINING.

The following are a few of the essential facts or laws that give character and utility to the Ling system: —

"Muscular development of any part of the body occurs in direct relation with the active movements to which the part has been subjected."

"Man has, in his own organs of movement, an efficient means for the preservation or restoration of health."

Every valuable gymnastic movement has a well-defined physiological or psychical object, and a definite beginning and end; requires a certain degree of effort or exertion through will and muscle; is performed in a determined time and rhythm, and describes a definite "figure" in reaching its end.

"The gymnastic value of a movement depends upon how it combines the greatest effect on the body with simplicity and beauty of performance."

Movements may follow each other in such an order, or may be so combined or co-ordinated as to increase not only the general bodily energy, but also the strength and functional power of the weaker parts of an organism.

"It is not the greater or lesser power of any part that determines the strength or weakness of an individual, so much as the proportion and harmony of the several parts."

"In bodily development, beginning with the simplest, you may gradually advance to the most complicated and powerful movements; and this without danger, inasmuch as the pupil has acquired the instinctive knowledge of what he is or is not capable."

The Swedish movements are classified with reference to their effects on nervous action, respiration, circulation, digestion, and secretions. The following is Ling's classification: —

Order movements: To gain attention and good position.

Movements for the back and chest: To strengthen the extensors of the back and to straighten the back; also, to expand the anterior and lower part of the chest.

Heave movements (various forms of lifting the body by means of the arms): To expand the upper part of the chest, and, incidentally, to strengthen the arms.

Balance movements: To give a correct carriage and general equilibrium.

Shoulder-blade movements: To flatten the upper part of the back, and to pull the shoulders backward.

Movements for the abdomen: To strengthen the outside muscles of the abdomen, and to affect digestion.

Alternate trunk-movements: To strengthen the lateral parts of the trunk.

Slow leg-movements: To increase the circulation in the lower limbs, to quiet the action of the heart, and to counteract palpitation.

Jumping and vaulting: To cultivate speed of motion, and — as these exercises require the activity of the

whole body at one time — to effect the co-ordination of movements.

Respiratory movements: To increase the capacity of the lungs, to restore breathing to its normal rhythm, and to help counteract the evil effects of precipitate movements.

Each of these classes of movements contains a variety of exercises suited to the age, physical condition, progress, and skill of the pupils. Usually, one exercise at a lesson is taken from each of the ten classes, and in the order of these classes. Sweden has proved that the average teacher, after suitable study, drill, and direction, can conduct these exercises with safety to the pupils, and with good physical and mental results. Moreover, the variety of exercises, the gradual increase of effort and skill required for their exact performance, the general refreshment that they give, and their ability to remove weariness and the ill-effects of too great or too long exertion, — all these go to show that the Swedish gymnastics not only train, but also interest the pupils.

CHAPTER II

OBSERVATION AND DEMONSTRATION LESSONS

MANUAL TRAINING

Observation and expression should invariably be associated in school work for the child. They must be constantly related to each other not only in spontaneous oral expression, but in written language, drawing, and as many other forms and materials as circumstances admit.

The time laid down in the Course of Study for observation lessons is two hours a week. The study of form, size, color, and qualities of objects, plant and animal life, geographical forms, measurement, etc., are specified. It is quite legitimate that the study of these subjects and the training of the senses, to which the observation of these subjects is intended to contribute, should be also carried on by expression or demonstration lessons, in order to secure complete and accurate knowledge. We may therefore use at least half the time allotted to such study, for training in expression not only in spoken or written words, but by hand or tool with appropriate material for such practice in manual training.

In order to connect the kindergarten with the primary school so as to make early school education one harmonious development, we must carry up some of

the kindergarten methods and incorporate them with the primary methods, inter-relating both programmes of work. This is easily done by making some of the kindergarten occupations tributary to the study of form, size, color, etc., as laid down in the primary course of study. The demonstration lessons may be actual lessons on these subjects as truly as the observation lessons.

Clay-modelling, paper folding and cutting, tool-work on wood, and sewing, may be added to drawing, now already in the primary course, and all to be used for expression or demonstration lessons in connection with observation lessons, all being in the line of the training of the senses and practice in form and measurement. These should be so related to each other and to language lessons in connection with observation as to constitute a systematic course of training for the child in preparation for its grammar-school course. The child naturally combines all his methods of activity, and should not be required to separate them and isolate them, but rather to keep alive a vital connection underlying all modes of development. Therefore it is best to regard all these various avenues to attainment as one and the same in purpose, in spirit, and in educational result.

It is recommended that paper folding and cutting be confined to the two lower classes of the primary school, wood-work to the upper class, while clay-modelling, drawing, and sewing may be given to all the classes; scissors, paper, and cardboard, clay, the moulding-board and spatula, knife and wood, cloth, needle and

thread being the necessary tools and material. The paper folding and cutting may serve also for lessons in color as well as form by the use of colored papers, and solids as well as geometrical plane figures may be represented in the second year; geometrical as well as object drawing should accompany all these lessons in form.

The clay-modelling may follow the plan of the kindergarten course both in the line of geometrical forms and free originative design; in the third year geographical forms should be attempted in clay, first the outline and surface forms of land, then the forms in relief of continents and geographical localities and features, until the child has some facility in producing them from memory. Objective drawing of the forms produced should follow clay-modelling invariably, the child being trained to draw only what is seen and as it is seen.

CHAPTER III

MORAL TRAINING INVOLVED IN MANUAL TRAINING

It is shown by experience that the introduction of such demonstration lessons as a part of the course in observation lessons will furnish the best educational occupation, will fix, complete, and vivify the results of observation, and lead to an unconscious moral training in habits of industry and power of work for useful ends, as well as in the practice of some of the most essential and constructive virtues, such as patience, neatness, order, exactness, courtesy, helpfulness, economy, and many of the elements which most effectually build up character.

We all agree that a great part of the discipline of the schoolroom is applied to the physical restlessness inevitable to a healthy boy during enforced physical inactivity. If a child is quick to learn, and gets the assigned lesson in advance of the majority of the class, or understands the explanations of the recitation so readily as to feel no need of prolonged attention, he is naturally apt to engage himself in some play or mischief which has no moral significance whatever, but which may draw upon him the condemnation of the teacher, and produce a sense of injustice under punishment, which results in vicious determination and tends to deprave the nature.

A wise teacher will give such a boy something to do, to occupy his hands or feet or head, and prevent serious trouble; she will not at once attach bad motives to a mischievous disposition under such circumstances. How often would a gentle suggestion or quick turning of attention set everything right, where accusation and penalty set everything wrong! An offered employment, which makes a child feel helpful, the chance to do or make something, which induces self-respect, creates a good motive, and absorbs the attention; the ignoring of an accidental offence or the avoidance of an issue with a wilful child, — the substitution of a good object of activity for an indifferent or poor one, — is much more philosophical than an arbitrary command, a challenge, or a threat.

We must have manual training systematically introduced, in the primary and grammar schools, not only for its value as an element of intellectual power, but for its moral power of toning up the whole nature, of satisfying the irrepressible activities of a child, and of giving him self-respect and courage.

To see the children in the primary classes busy with their clay, each one with a board, spatula, and clay, — moulding from pictures or models, or from plant-forms, — is indeed encouraging. The leaf, the flower, the square, the cube, the polygon, the dog, the cat, the horse, the head of Washington, — are a sample of what is done in the New York primary schools, by boys and girls from the most unfavorable home-surroundings, without culture, with only a few months of practice, but with the most astonishing results. It is the

mud-pie propensity transfigured into true educational method.

The paper cutting and folding and Slöjd work in wood, the designs in color and form in clay, paper, and wood, as well as in cardboard and sewing, are all done in the lower grade of the New York schools; and the happy, absorbed work of the children, the eagerness to produce something correct and beautiful, is most inspiring to one who seeks the solution of the moral question in education.

CHAPTER IV

HAND AND TOOL WORK

THE manual training introduced by the kindergarten should be carried up into the primary and grammar schools on at least some of its lines of development.

Paper folding and cutting, as well as sewing, clay-modelling and drawing should occupy some portion of the course of study in the lower primary classes, while the use of the knife on wood should be added to these for the first class of the primary schools, and carried on with other tools, into the lower grammar grades, perhaps as an elective with sewing and cookery. In this way the kindergarten will prepare for primary-school work, and each grade will be the development of that immediately preceding it, so as to secure uniformity of method and unity of purpose in the school system.

PAPER FOLDING AND CUTTING.

This involves the use of the scissors, and may be introduced as a part of the study of form, size, and color, in observation lessons in primary schools. By folding a paper symmetrically and then cutting it more or less simply, it will open again into a form of symmetry and beauty. Little children will soon devise patterns and cut them, or even tear them, in pretty forms,

and color may be a part of the lesson through the use of colored papers. Geometrical figures may be cut in cardboard and the sides joined so as to form prisms, as a study in solid figures. Folding may be used as an aid in studying geometrical forms in a most practical and effective manner. The following is a lesson of this kind, given by one of the graduates of Miss Page's kindergarten training-class : —

GEOMETRIC EXERCISE IN PAPER-FOLDING.

(*For Children beyond the Kindergarten.*)

Children, of what shape is the paper I have given you? It is square. How do you know it is square? Because it has four equal sides and four equal angles.

Fold a diagonal line. Is a diagonal always a slanting line? It is not. What is a diagonal? A diagonal is a straight line connecting two angles, not adjacent.

Of what shape is your paper now? Triangular. What kind of a triangle is it? A right isosceles triangle. What part of the square is it? One-half. What may you learn from this? That a triangle is equal to half a square whose base and height are equal to its own.

What else was divided in dividing the square? The angles. What may we learn from this? That as the diagonal line divides the whole square into two equal parts, so it divides each right angle from which it proceeds into two equal angles [each is half a right angle], 45 degrees.

To what is the sum of all the angles in this triangle equal? To two right angles. What is the sum of all the angles in every triangle equal to? To two right angles.

Where is the greatest side of this triangle? Opposite the greatest angle, namely, the right angle. Is the greatest side of a triangle always opposite the greatest angle? It is. What do we call the side opposite the right angle in a right triangle? The hypothenuse.

Fold a line from side to side through the centre. What do we call such a line? A diameter. Into what does it divide the square? Into two equal rectangles. Show me the base (?) of the rectangle. Show me the base of the triangle. Are they the same? They are. Are the sides alike? No, the side of the rectangle is equal to one-half the height of the triangle. What may be learned from this? That a rectangle is as great as a right isosceles triangle, when it has the same base, and half the height.

Since folding the diameter, what new angles do you see? Two obtuse and two acute. How are they situated? Acute opposite acute, and obtuse opposite obtuse. What is true when two straight lines cut each other? The opposite or vertical angles are equal.

Fold the same diameter again, and place the paper with the folded side toward you. Now put the right edge over on to the left, and crease. Open your paper and tell me what you see. Four small squares. What shape did you say your paper was? Square. Then, what do you see from this? That you may have forms alike in every respect but size.

How many angles do you see about the centre of your paper? Six. How many right angles do these six make? Four right angles. State the proposition that may be proved by the aid of this. The sum of all the angles formed about a point in a plane is equal to four right angles.

1. Will you hold your paper by the crease [two oblongs]. The adjacent angles on one side are equal to what? To two right angles. Then how much greater is this obtuse angle than the acute? The obtuse angle is as much greater than a right angle as the acute angle is less than a right angle.

How is a right angle formed? By the meeting in a point of two perpendicular lines in the same plane. What is the size of a right angle? Ninety degrees, or one-quarter of a circle. Can it have more than one size? No. Can an acute angle or an obtuse angle have more than one size? Yes.

Place the square before you again, and fold the other diagonal.

2. Fold on the diameter of the square and tell me what tri-

angles you see. Four small and one large right isosceles. How many small triangles contained in the larger one? Two. How long is its base line? As long as the rectangle. How high is it? As high as the rectangle. What can you learn from this? That a right isosceles triangle is equal to half a rectangle having the same base and height. Also: The line drawn from the vertex perpendicular to the base of a right isosceles triangle divides it into two equal isosceles triangles.

Place the open square before you. Into what did the diagonals divide the square? Into four equal right isosceles triangles. Each is what part of large square? One-quarter. Into what did the diameters divide square? Into four equal squares. What part of large square is each? One-quarter. Therefore, what? Each square is equal to each triangle. [Two things, each equal to a third, are equal to each other.]

What part of each small square is each small triangle? One-half. What part of large square is each small square? One-quarter. What part of the large square is each small triangle? One-eighth.

SEWING.

Sewing as a branch of manual training and as a part of that training of sight, touch, and sense of measurement, which is so important an element of the observation lessons, should be taught by the class teacher in short object lessons with the whole class in concert, beginning with the presentation of the right method of holding the work and needle, of taking stitches evenly and regularly, of turning seams evenly and regularly, and so on, until both boys and girls have mastered the elements of sewing. Each child should have a strip of cloth, either as material for the whole series of lessons or a separate piece for each lesson, which should be kept by the teacher and handed to the pupil at each lesson

and should be used only for the lessons. The children should be allowed to practise on other pieces of cloth for their own occupation and purposes as busy-work.

These lessons should teach accuracy of movement, precision and regularity of manipulation, the right use of thimble, scissors, needle, and thread, as well as neatness and order and the elements of needle-work. At the close of the primary course, both boys and girls should be able to show their samplers of stitches, from the overtop seam and basting, through hemming, felling, back-stitching, running, gathering, and over-casting, to mending, darning, and patching. Perhaps some embroidery on canvas, with colored worsteds, may follow the perforated-cardboard work of the kindergarten, as an occasional recreation. The teacher should show the method of forming a stitch by illustration on the blackboard, before the class, and actual work with needle and sampler large enough for all to see.

CLAY-MODELLING.

The use of clay in the kindergarten is very well adapted for development on the same lines in the primary schools. Any form which is made the subject of observation may be attempted by the pupils with clay, and, when satisfactorily produced, may serve as a model for object-drawing. Some geographical forms may be thus attempted in the upper primary classes, so as to secure a vivid comprehension of the elementary ideas of geography. Land and water contours and surfaces may be learned in this way much better than

in any other. An island, peninsula, cape, isthmus, and continent, as well as a sea, gulf or bay, channel and strait, may be formed by moulding the clay and then pouring water upon it so as to submerge the lower parts. Mountains, plateaus, plains, and rivers may be produced in the same way, and thus clay-modelling will lay the foundation for further geographical study, in the best manner. Geometrical solids can be learned by clay-modelling, as well as by paper folding and cutting. Freedom in the use of the clay should sometimes be allowed as an opportunity of embodying the creative imagination of the child and arousing his artistic impulse; and models of artistic form should be sometimes presented for him to attempt to copy. The child's ingenuity and productive instincts, under the inspiration of his own interest and the sympathy of the teacher, will lead to the greatest variety of forms for use and recreation, or for the beginning of art-culture.

DRAWING.

If children in the primary schools could supplement an observation lesson by an attempt to draw the object just as they see it, the best beginning would be made in the art of drawing. Also if a story or even a single idea could be illustrated by the child in the most simple way, — by a few lines and crude figures, — much would be done to secure the child's love for drawing, and the legitimate use of it as a means of expression. This method is more natural and effectual for children than the analytical plan, which gives them practice in

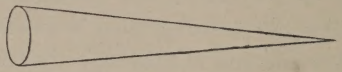
lines for a long time before attempting object-drawing. Drawing should follow modelling rather than precede it. The effort of the pupil should be to draw only what he sees. Drawing should be taught as reading now is, by attaching the expression immediately to the observation. The object is first presented to the child in both reading and drawing, then in reading the word is taken as a whole and not through its alphabetical or even phonic elements, as by the old method; so in drawing the whole graphic expression should follow the observation of the object rather than the elemental idea of lines or dots, as has been the artificial and analytical method. Of course, practice in lines may be carried on simultaneously, with object drawing as in the kindergarten, with the aid of ruled squares, etc., and this practice is also involved in copying the designs produced by paper-cutting and modelling geometrical forms.

In every exercise the class should be encouraged to illustrate the object of observation or mental image before them by any appropriate hand or tool work. Let pupils often go to the board to draw for the class, making a few outlines or graphic strokes answer for illustration. Cultivate the habit of drawing objects embodying the child's ideals or interests, and always prefer bold outlines of light and shade to more exact or elaborate drawings. The grotesque should sometimes be represented.

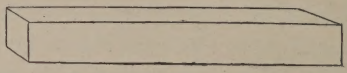
KNIFE-WORK IN WOOD.

In the third primary school year the knife may be put into the hands of the pupils.

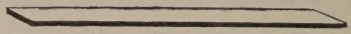
The wood-cutting with the knife may begin by cutting a long piece of soft wood in the form of a cone thus:



next a rectangular prism may be cut thus:



from the last may be cut thin longitudinal strips as well as cubes and other prisms, and so on by as many



stages of advance in manual skill as the conditions of the class may allow, including wood-carving to some extent. The children should be encouraged to attempt original work for the embodiment of their fancies, and toys and utensils as gifts or for use; inventions and designs of various kinds will be naturally undertaken by many of the children, and should not be closely criticised; thus a great deal of otherwise unoccupied time both at home and at school can easily be occupied in this development of the child's originative power. Models of jointed figures cut from flat wood, which can be made to simulate movements of life, are given by Miss Marwedel in the charts of "The Missing Link."

After geometrical plane figures have been drawn in

bold relief on clay and then copied on paper, the lines on the paper may be covered by thin strips of wood carefully cut, then joined by three or four kinds of joints and neatly glued on the paper; this will be one advanced kind of wood-work in geometrical forms for the last part of the year.

The following articles may be cut by a first primary class from soft pine or maple, or from old cigar-boxes, with only a sharp knife: —

Long cone, long rectangular prism, cube, and other geometrical forms for building; thin strips or slats, wedge, label, tag, button or double wedge, peg, penholder, thread, silk or fish-line winders, clothes-pins, spade, paper-knife, fruit-knife, plate, spoon, fork, bat, whistle, wind-mill, rake, ladder, spatula, letter-opener, pen-rack and other racks, geometrical plane figures, as square, triangle, etc., bracket, easel, sled, frame, tray, cart, toys and doll's furniture, box, candle-stick, bread-plate, table-mat of alternate strips of dark and light wood glued to cloth of the right shape, checker-board made in a similar way, kite-frame, clappers, plant-forms or conventional patterns cut from flat wood on which the outline has been drawn, grotesque figures cut in parts which may be loosely hung together with wire so as to simulate living movements when vibrating, as monkeys jumping over a stick, dancing clowns, etc.

Perhaps there is no course better adapted to instruction in this direction than the Swedish Slöjd.

THE PURPOSE, RULES, AND PLAN OF THE SLÖJD.

Extract from a Manual by G. Larsson.

The purpose of the SLÖJD-INSTRUCTION is to give general skill to the hands, and particularly to broaden the child's mind, and excite a love for work in him.

It is to instil the importance, benefit, and pleasure of order and exactness.

It also teaches the necessity of attention, diligence, and perseverance.

The models must be of such a character as to be subject to the following rules: —

1. Let the exercises be of such a character as to interest the children.
2. Let them be objects of practical use.
3. Let them promote general dexterity.
4. Let them promote order and accuracy.
5. During exercises, cleanliness and good order must be required.
6. Let the exercises increase the children's ability and strength.
7. Let the models be in some degree designed to cultivate æsthetic taste.
8. Let the exercises train the practical insight and develop the constructive (or inventive) faculties.
9. Let them counteract sedentary occupations.
10. Let them develop and strengthen the body.
11. Let them be ordered with methodical progression.

The models ought to be arranged in such order as to give the pupil a strictly progressive knowledge of using the tools, and so that the pupil at any stage may be able to execute an exact copy of the model. However, the series of models must not be considered as essential and unchangeable.

The system is not characterized by the models, but by the exercises which the models represent.

Thus the same system can be followed and applied with a different series of models; and on the other hand the same series of models may be used by a teacher having no idea of the system, when its value would be entirely lost.

The following table of the first six models shows that the order of the exercises is the essential quality of a series of models: —

No.	Model.	New Exercises.	New Tools.	Kind of Wood.	Dimensions. Inches.	Drawing.
1	Wedge.	Whittling.	Knife, Rule, and Lead Pencil.	Pine.	3 x 1 x ¼	Parallel lines.
2	Flower Pin.	Square Whittling.	Knife, Rule, and Lead Pencil.	Pine.	12 x ½	Parallel lines.
3	Flower Stick.	Square Sawing and Planing.	Splitting Saw, Jack Plane, Try Square, and Marking Gauge.	Pine.	15 x ½	How to find the centre in a square.
4	Penholder.	Curved Whittling and Boring.	Bit.	Hard Pine.	8 x ½	Freehand-Drawing of curved lines.
5	Cutting Board.	Round Sawing, Filing, and using of Block Plane.	Cross-cut Saw, Back Saw, Turning Saw, Compasses, Flat File, Block Plane, and Centre Bit.	Pine or White Wood.	17 x 6 x ¾	How to find the centre of a line and to draw a circle when you have the radius and two square tangents.
6	Flower Pot Stand.	Nailing and using of Bench Hook.	Hammer and Bench Hook.	Pine.	20 x 6 x ⅜	Continued Elementary Drawing.

GENERAL OUTLINE FOR DEMONSTRATION LESSONS.

One hour per week added to the two hours for Observation Lessons.

Straight lines drawn on paper measured by inches.

Straight lines drawn on clay measured by inches.

Straight lines folded in paper measured by inches.

Straight lines cut in paper of various colors.

Straight lines cut in clay with knife or spatula.

Straight lines sewed on cloth, taking up threads by twos or threes.

Straight lines with all the material produced in different directions and relations, as *horizontal*, *vertical*, *oblique*, *perpendicular*, *parallel*.

Curved lines, broken lines, irregular lines, margins of leaves and outlines of life forms produced in all the material; straight lines cut in wood with the knife or saw.

The square, the triangle, the pentagon, and other forms used in the drawing lessons may be produced in all the material, and combined with observation lessons in size and color as well as in number, language, and elementary science; comparison of size, harmony, and contrast of color, composition of color, and shades of color are studied by making these forms of different sizes and colors in paper cutting and sewing, or by washes of color on drawings.

The moulding of the sphere, cube, and cylinder in clay.

The folding and cutting of the same in paper.

The cutting of the same in wood.

The objective drawing of the same on paper or blackboard.

The division of these forms in all the material into halves, quarters, etc.

Objective moulding and drawing, also cutting and sewing, of modifications of these typical forms in plant and animal life, as *leaves*, *flowers*, *fruits*, *vegetables*, *star-fish*, *sea-urchin*, etc.

Objective moulding, drawing, cutting, and sewing of forms of life, toys and implements, according to the fancy or originative construction of the child.

Color should be combined with form in every case practicable, as nature shows us form through the eye by color only. Colored threads and colored papers or washes of color should be used.

The sewing of the primary schools should be differentiated from that of the kindergarten by the use of the common material and implements and the common stitches of sewing as presented in the grammar grades. The cloth, however, should be coarser, the needle larger, the thread of various colors, the stitches only the elementary ones, and executed in concert with class instruction, and by counting threads; the cloth should be uniform for all — in small pieces at first, and no garments should be worked upon for the class lesson; the holding of the work and the needle, the threading of the needle, the use of the thimble, the position of the hands, the head, and the whole body should be the subjects of the first few lessons. The children should be allowed and encouraged to apply

the lessons to work of their own as "busy work," or home-work, and to copy life, to originate and design with all the material for manual training.

The work with the knife on wood or cardboard may be given in the last year of the primary course.

The position of the body and the method of manipulation should be regarded as of the first importance in all these lessons.

The prescribed time for the observation and demonstration lessons being together three hours per week, they may be combined and related within that limit to any extent.

These general directions and suggestions may be adapted and arranged for each school and class by the teacher, according to her own conditions and plan of work. The teachers should be free and originative, consulting the individuality of their pupils and themselves as far as possible within the requirements of general uniformity and proper grading.